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(54) **FLEXIBLE DISPLAY DEVICE INCLUDING HEAT DISSIPATION STRUCTURE**

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(Continued)

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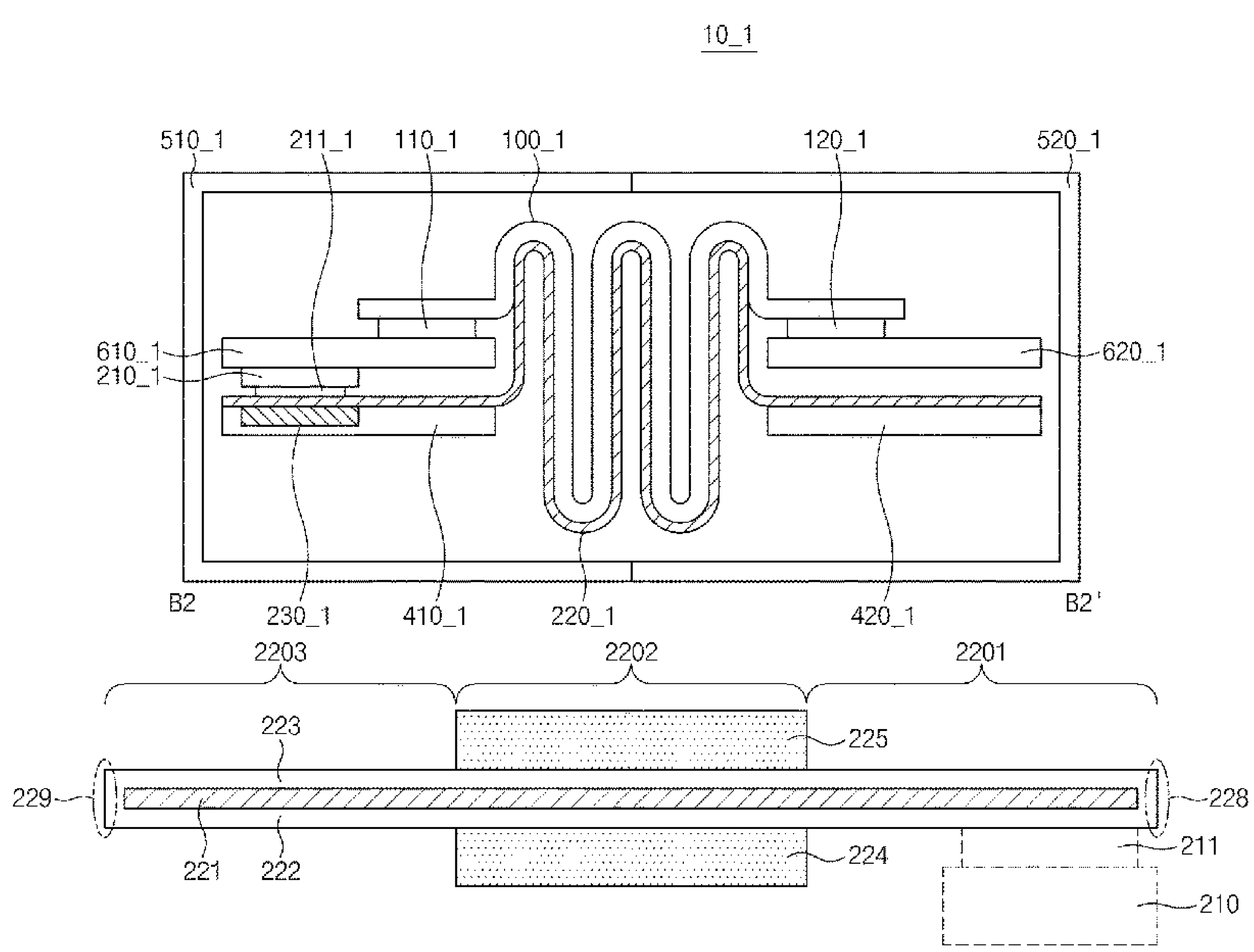
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

A flexible display device is provided, which includes a first housing, a second housing, a hinge structure that connects the first housing and the second housing and supports a hinge motion of the first housing or the second housing, a heat source disposed in the first housing, a heat sink disposed in the second housing, and a heat-dissipation path structure disposed across the first housing, the hinge structure, and the second housing. The heat-dissipation path structure transfers heat generated by the heat source to the heat sink.

19 Claims, 13 Drawing Sheets



(51) **Int. Cl.**
H05K 7/20 (2006.01)
H05K 1/18 (2006.01)
H05K 1/02 (2006.01)

(52) **U.S. Cl.**
CPC ***H05K 1/0209*** (2013.01); ***H05K 1/189*** (2013.01); ***H05K 7/2039*** (2013.01); ***H05K 7/20509*** (2013.01); *H05K 2201/10128* (2013.01)

(58) **Field of Classification Search**
USPC 361/704
See application file for complete search history.

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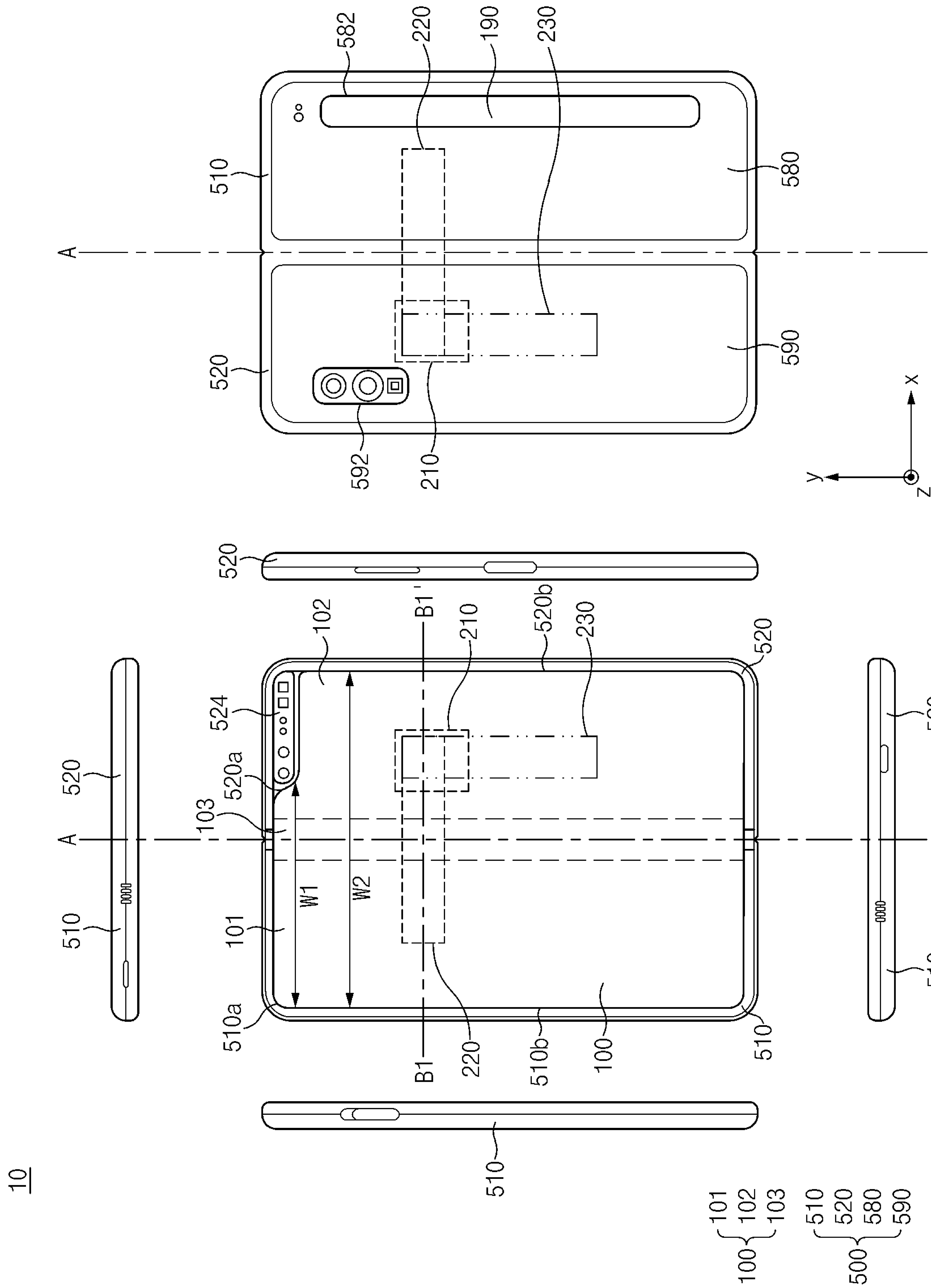
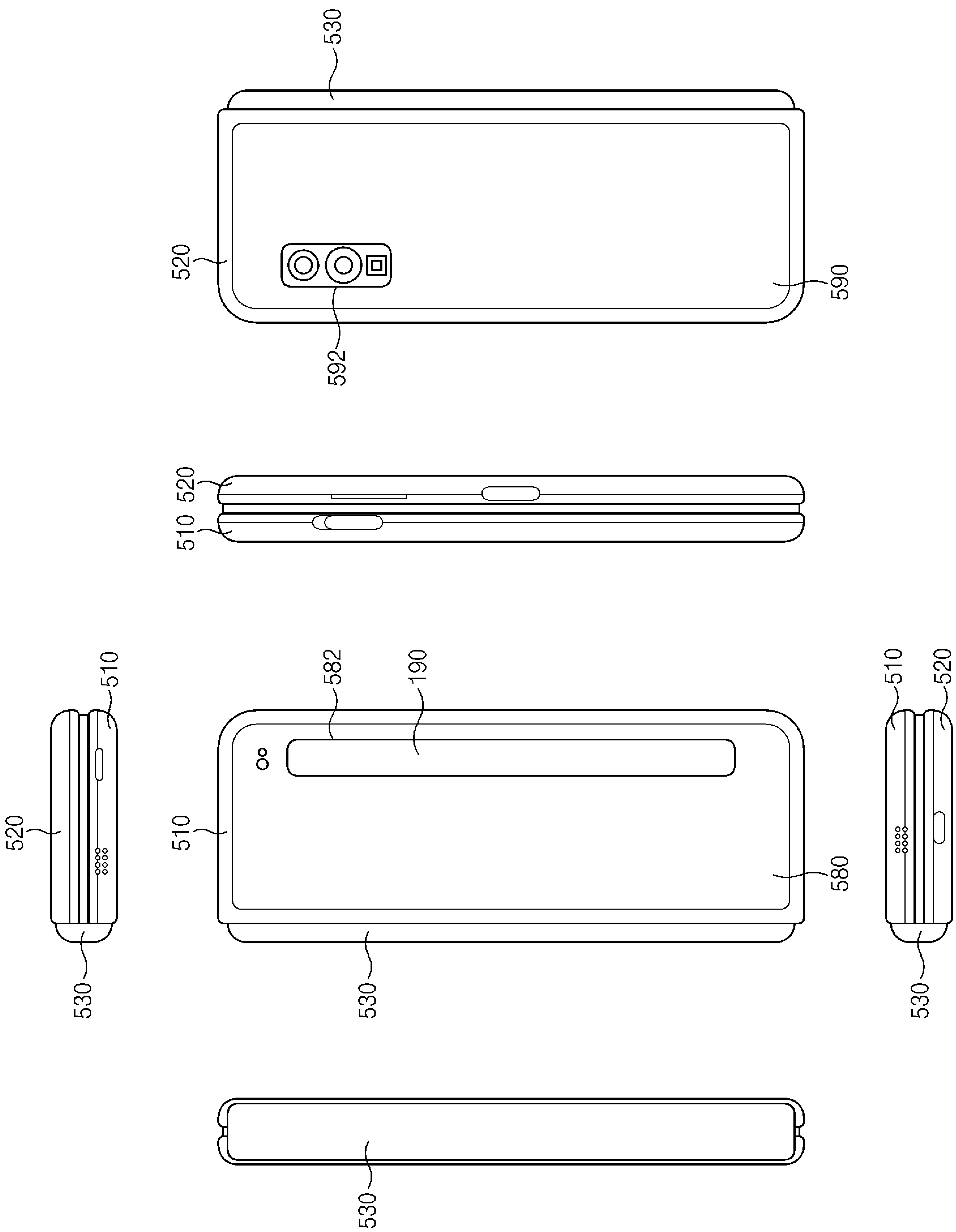

582
220
190
230
510
580
A
520
590
592
210
x
y
z
520
102
B1'
210
520b
230
520
524
520a
103
101
W1
W2
510a
B1
220
510b
100
510
10
101
102
103
100
510
520
580
590
500

FIG.1A


530
520
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592
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510
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582
190
510
520
520
510
580
530
530
530
530

FIG.1B

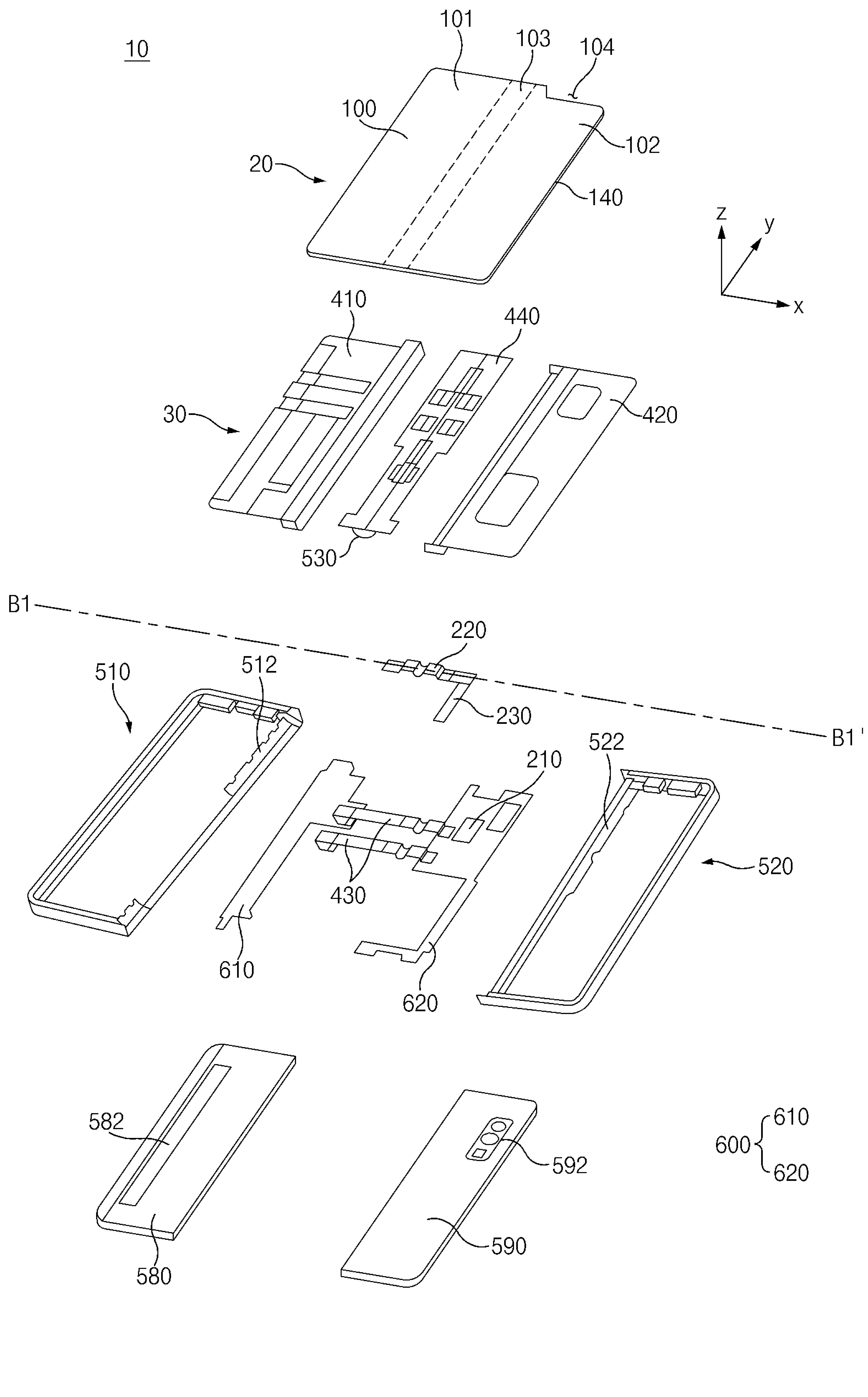

10
101
103
104
100
102
20
140
z
y
x
410
440
30
420
530
B1
220
230
B1'
510
512
210
522
520
430
610
620
582
610
600
620
592
590
580

FIG.1C

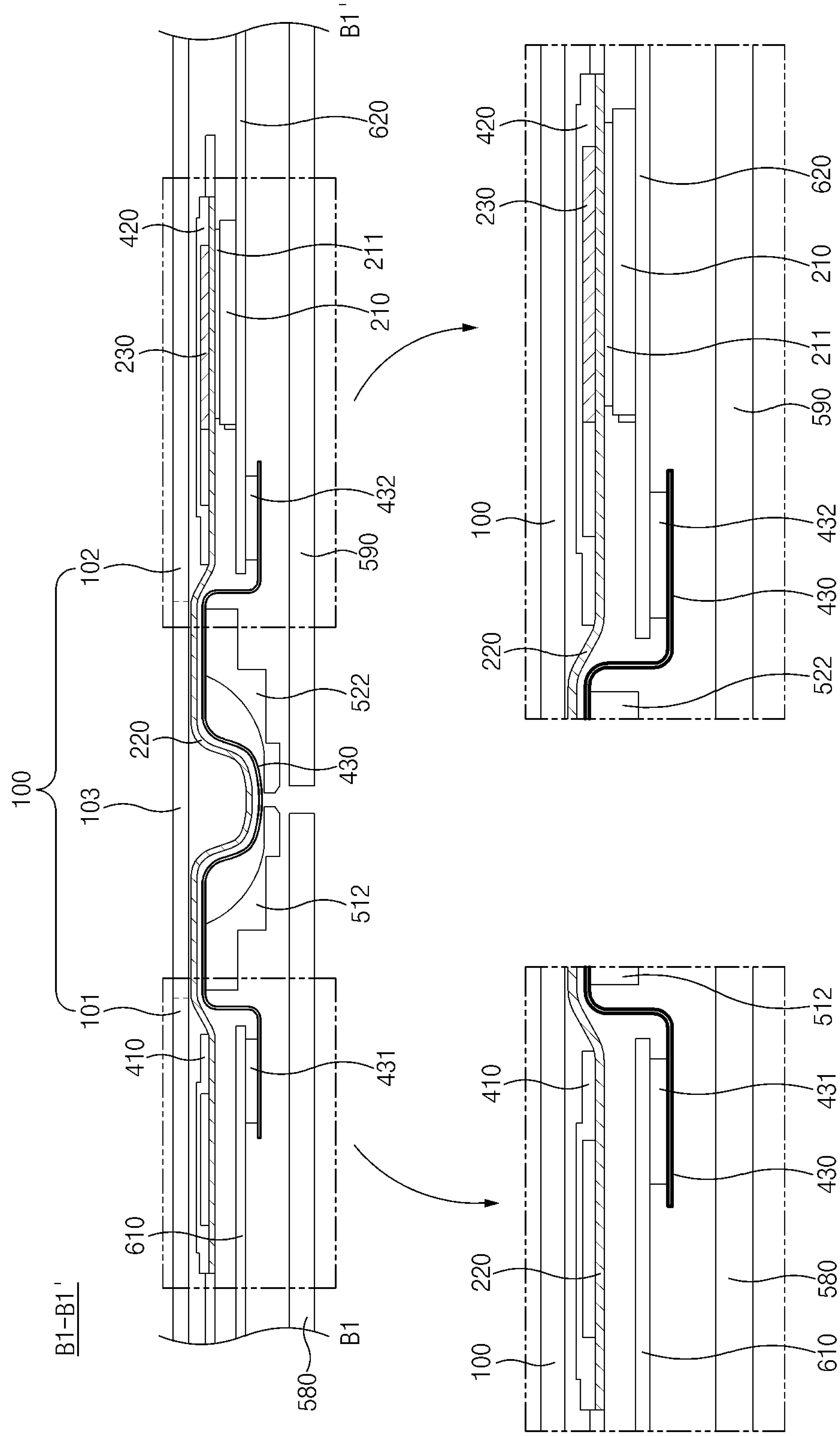

B1-B1'
B1
B1'
100
101
102
103
210
211
220
230
410
420
430
431
432
512
522
580
590
610
620

FIG.2

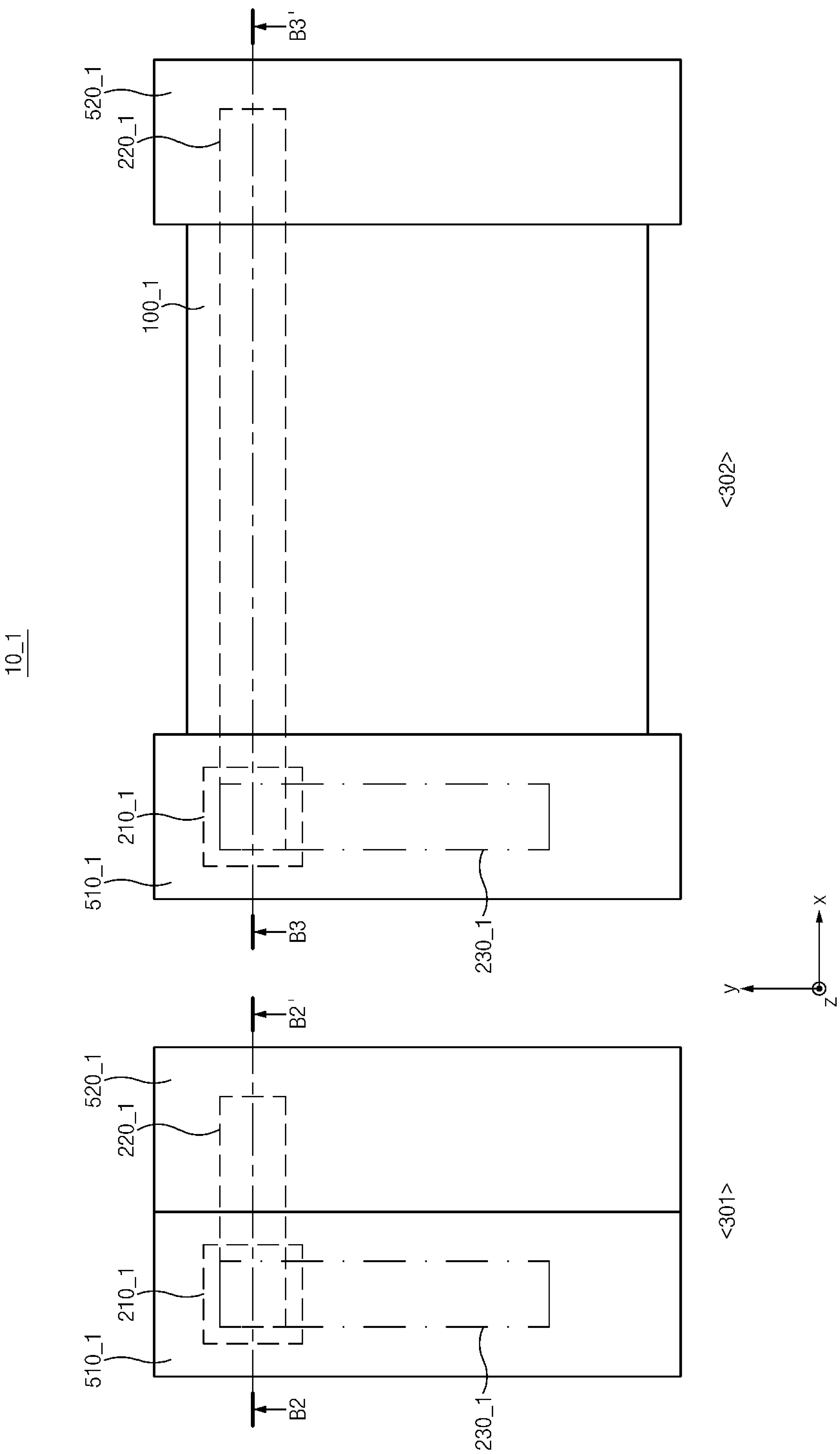

10_1
520_1
220_1
100_1
B3'
B3
210_1
510_1
230_1
<302>
x
y
z
B2'
520_1
220_1
210_1
510_1
B2
230_1
<301>

FIG.3

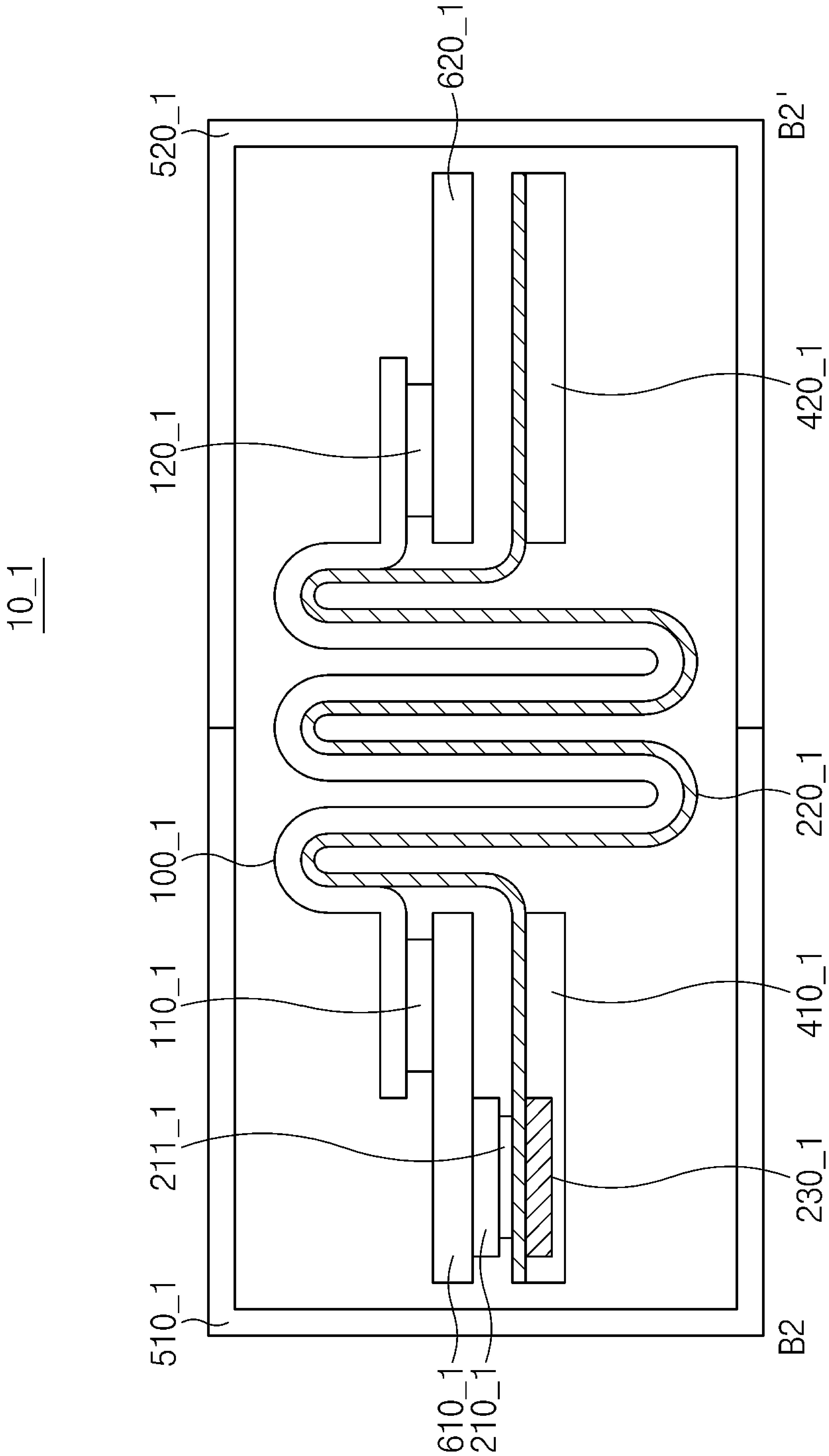
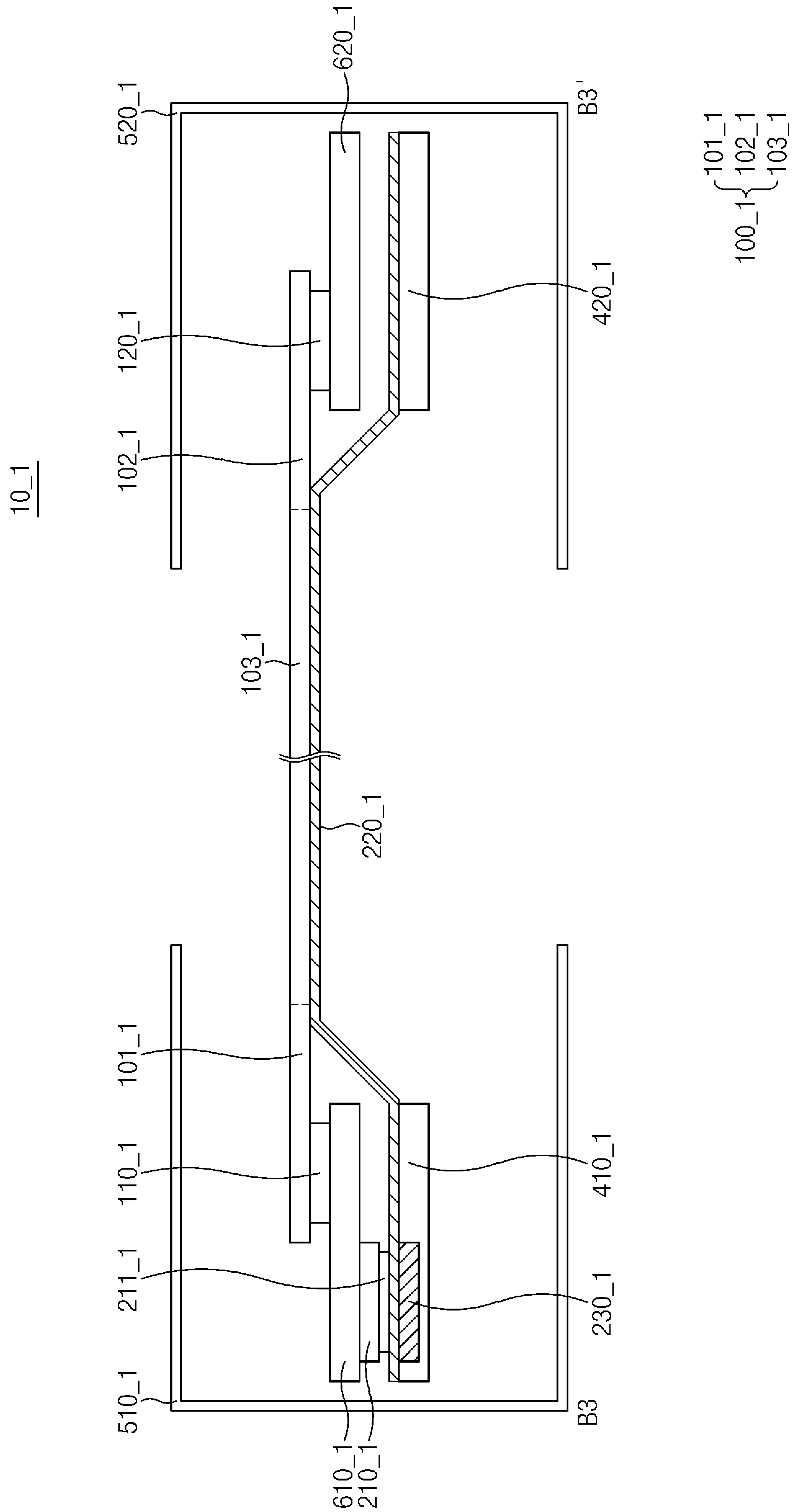

10_1
520_1
620_1
B2'
120_1
420_1
100_1
220_1
110_1
410_1
211_1
230_1
510_1
B2
610_1
210_1

FIG.4A


10_1
520_1
620_1
B3'
101_1
102_1
103_1
100_1
120_1
420_1
102_1
103_1
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211_1
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510_1
B3
610_1
210_1

FIG.4B

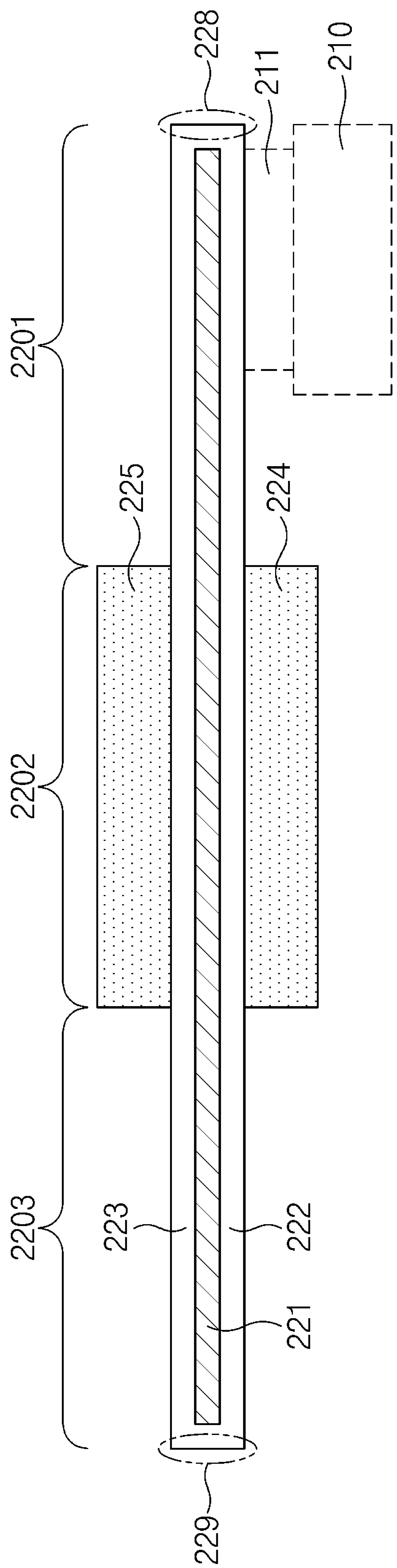

FIG. 5

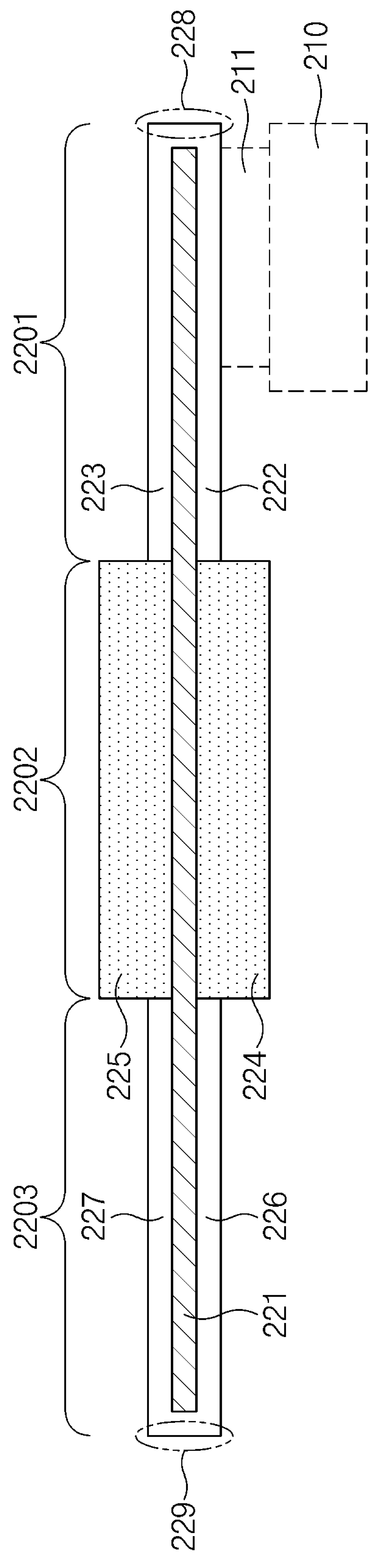

FIG.6

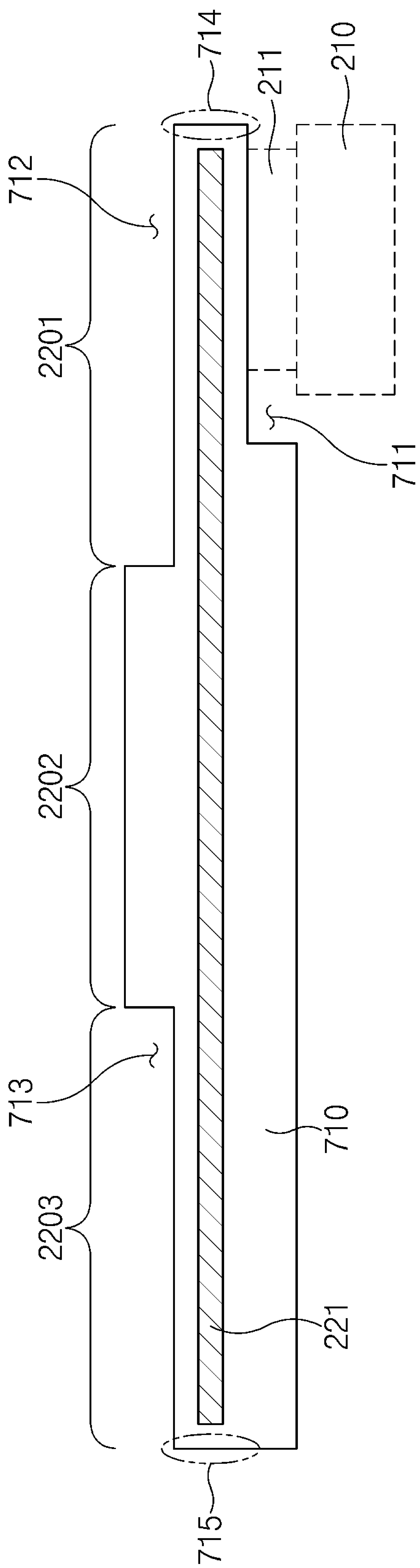

FIG.7

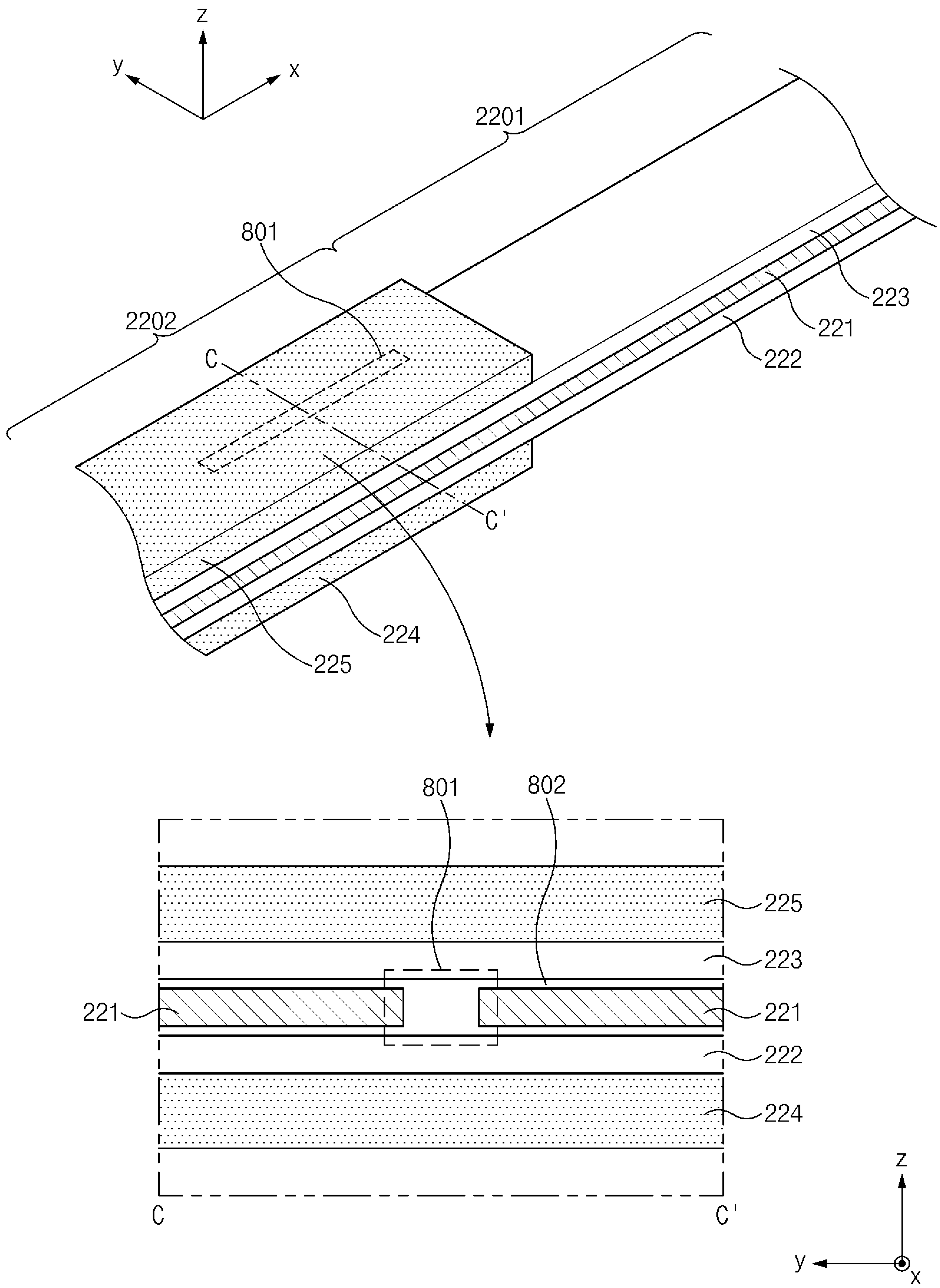
z
y
x
2201
801
2202
C
C'
223
221
222
224
225
801
802
225
223
221
221
222
224
C
C'
z
y
x

FIG.8

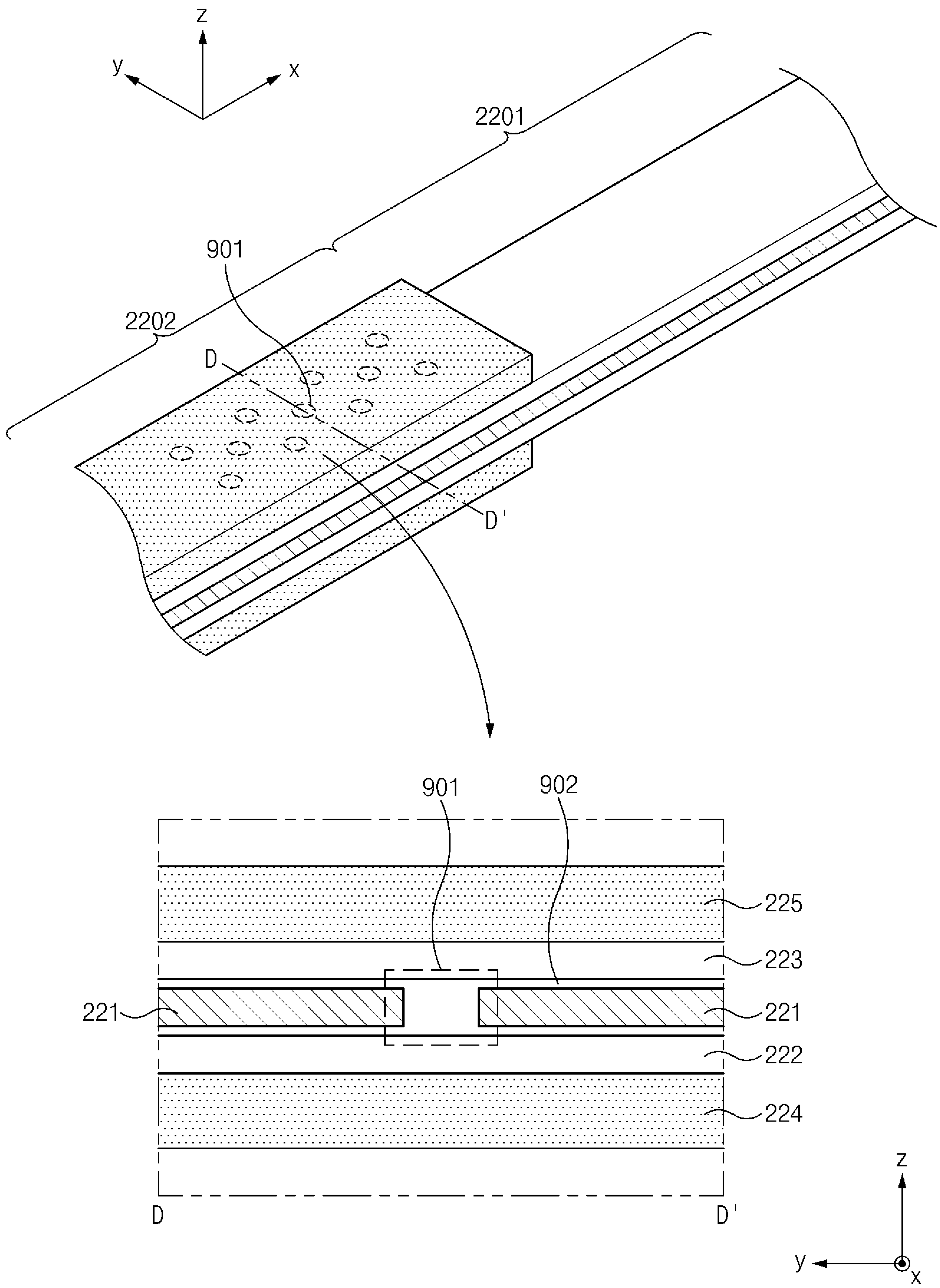

FIG.9

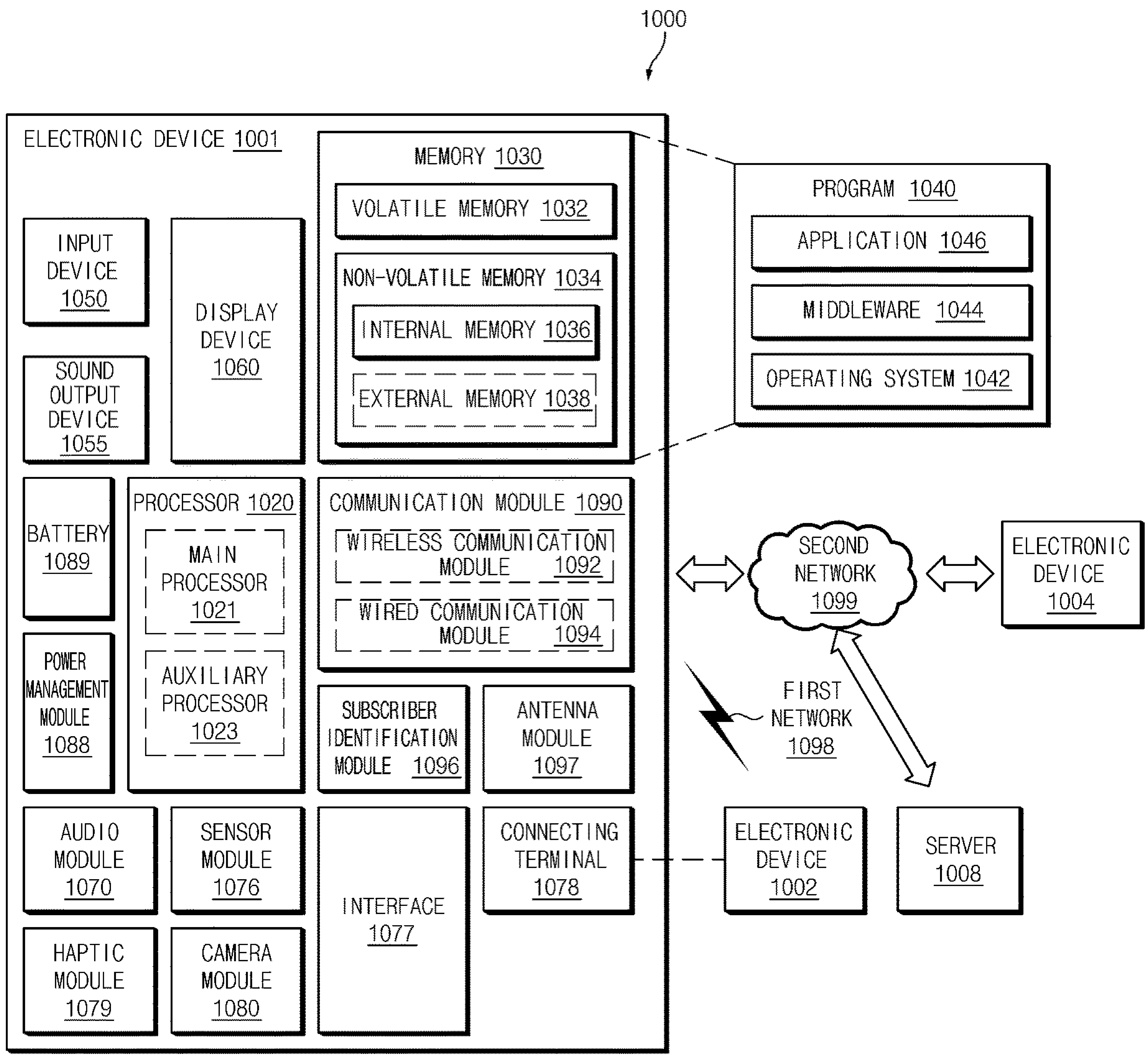
1000
ELECTRONIC DEVICE 1001
INPUT DEVICE 1050
SOUND OUTPUT DEVICE 1055
DISPLAY DEVICE 1060
MEMORY 1030
VOLATILE MEMORY 1032
NON-VOLATILE MEMORY 1034
INTERNAL MEMORY 1036
EXTERNAL MEMORY 1038
PROGRAM 1040
APPLICATION 1046
MIDDLEWARE 1044
OPERATING SYSTEM 1042
BATTERY 1089
POWER MANAGEMENT MODULE 1088
PROCESSOR 1020
MAIN PROCESSOR 1021
AUXILIARY PROCESSOR 1023
COMMUNICATION MODULE 1090
WIRELESS COMMUNICATION MODULE 1092
WIRED COMMUNICATION MODULE 1094
SUBSCRIBER IDENTIFICATION MODULE 1096
ANTENNA MODULE 1097
SECOND NETWORK 1099
ELECTRONIC DEVICE 1004
FIRST NETWORK 1098
AUDIO MODULE 1070
SENSOR MODULE 1076
INTERFACE 1077
CONNECTING TERMINAL 1078
ELECTRONIC DEVICE 1002
SERVER 1008
HAPTIC MODULE 1079
CAMERA MODULE 1080

FIG.10

FLEXIBLE DISPLAY DEVICE INCLUDING HEAT DISSIPATION STRUCTURE

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is based on and claims priority under 35 U.S.C. § 119 to Korean Patent Application No. 10-2019-0054917, filed on May 10, 2019, in the Korean Intellectual Property Office, the entire disclosure of which is incorporated herein by reference.

BACKGROUND

1. Field

The disclosure relates generally to a dissipating heat generated from a flexible display device.

2. Description of Related Art

A portable electronic device, such as a smartphone, may provide various functions, such as telephone call, video playback, Internet search, etc., based on various types of applications. A user may prefer the various functions be executed through a wider screen. However, an increase in screen size of a portable device may decrease portability. Accordingly, a portable electronic device using a flexible display has been developed.

In a portable electronic device, an application processor (AP) related to computational operation, a power management integrated circuit (PMIC) related to power supply and battery charging, and a communication processor (CP) related to communication may consume a significant amount of current and generate heat during operation. The heat may cause a problem in the stability of the portable electronic device and the safety of a user (e.g., a low-temperature burn). Therefore, it is important to manage the temperature of a component that generates heat in the portable electronic device.

SUMMARY

The disclosure is provided to address at least the above-mentioned problems and/or disadvantages and to provide at least the advantages described below.

An aspect of the disclosure is to provide a flexible display device including a heat-dissipation path structure extending across a first housing and a second housing to rapidly perform a heat dissipation operation.

In accordance with an aspect of the disclosure, a flexible display device is provided, which includes a first housing, a second housing, a hinge structure that connects the first housing and the second housing and supports a hinge motion of the first housing or the second housing, a heat source disposed in the first housing, a heat sink disposed in the second housing, and a heat-dissipation path structure disposed across the first housing, the hinge structure, and the second housing. The heat-dissipation path structure transfers heat generated by the heat source to the heat sink.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features, and advantages of certain embodiments of the disclosure will be more apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIG. **1**A illustrates a flat state of an electronic device according to an embodiment;

FIG. **1**B illustrates a folded state of the electronic device in FIG. **1**A according to an embodiment;

FIG. **1**C illustrates an exploded view of an electronic device according to an embodiment;

FIG. **2** illustrates a sectional view of the electronic device in FIG. **1**A taken along line B**1**-B**1**', according to an embodiment;

FIG. **3** illustrates an electronic device according to an embodiment;

FIG. **4**A illustrates a sectional view of the electronic device in FIG. **3** taken along line B**2**-B**2**', according to an embodiment;

FIG. **4**B illustrates a sectional view of the electronic device in FIG. **3** taken along line B**3**-B**3**', according to an embodiment;

FIG. **5** illustrates a heat-dissipation path structure according to an embodiment;

FIG. **6** illustrates a heat-dissipation path structure according to an embodiment;

FIG. **7** illustrates a heat-dissipation path structure according to an embodiment;

FIG. **8** illustrates a slit structure formed in a heat-dissipation path structure according to an embodiment;

FIG. **9** illustrates a dot structure formed in a heat-dissipation path structure according to an embodiment; and

FIG. **10** is a block diagram illustrating an electronic device in a network environment according to various embodiments.

With regard to description of the drawings, identical or similar reference numerals may be used to refer to identical or similar components.

DETAILED DESCRIPTION

Hereinafter, various embodiments of the disclosure may be described with reference to accompanying drawings. Accordingly, those of ordinary skill in the art will recognize that modification, equivalent, and/or alternative on the various embodiments described herein can be variously made without departing from the scope and spirit of the disclosure.

FIG. **1**A illustrates a flat state of an electronic device according to an embodiment. FIG. **1**B illustrates a folded state of the electronic device according to an embodiment.

Referring to FIGS. **1**A and **1**B, the electronic device **10**, which is a flexible display device, includes a foldable housing **500**, a hinge cover **530** that covers a foldable portion of the foldable housing **500**, and a flexible display **100** that is disposed in a space formed by the foldable housing **500**. The flexible display **100** may include a foldable display, a multi-foldable display, or a rollable display. A surface on which the display **100** is disposed is referred to as a first surface or a front surface of the electronic device **10**, and an opposite surface to the front surface is referred to as a second surface or a rear surface of the electronic device **10**. Surfaces that surround a space between the front surface and the rear surface are referred to as third surfaces or side surfaces of the electronic device **10**.

The foldable housing **500** includes a first housing structure **510**, a second housing structure **520**, a first back cover **580**, and a second back cover **590**. The second housing structure **520** includes a sensor area **524**.

The foldable housing **500** is not limited to the form and coupling illustrated in FIGS. **1**A and **1**B and may be implemented by a combination and/or coupling of other shapes or parts. For example, the first housing structure **510** and the first back cover **580** may be integrated with each other, and the second housing structure **520** and the second back cover **590** may be integrated with each other.

In FIG. **1**A, the first housing structure **510** and the second housing structure **520** are disposed on opposite sides of a folding axis A and are symmetrical with respect to the folding axis A. An angle or distance between the first housing structure **510** and the second housing structure **520** may vary depending on whether the electronic device **10** is in a flat state, a folded state, or an intermediate state.

Unlike the first housing structure **510**, the second housing structure **520** includes the sensor area **524** in which various sensors are disposed, but may have a mutually symmetrical shape in the other area.

As illustrated in FIG. **1**A, the first housing structure **510** and the second housing structure **520** may form a recess in which the display **100** is received. Due to the sensor area **524**, the recess may have different widths in a direction perpendicular to the folding axis A.

For example, the recess has (1) a first width W**1** between a first portion **510***a* of the first housing structure **510** that is parallel to the folding axis A and a first portion **520***a* of the second housing structure **520** that is formed on the periphery of the sensor area **524** and (2) a second width W**2** formed by a second portion **510***b* of the first housing structure **510** and a second portion **520***b* of the second housing structure **520** that does not correspond to the sensor area **524** and that is parallel to the folding axis A. The second width W**2** is greater than the first width W**1**. The first portion **510***a* of the first housing structure **510** and the first portion **520***a* of the second housing structure **520** that have mutually asymmetrical shapes may form the first width W**1** of the recess, and the second portion **510***b* of the first housing structure **510** and the second portion **520***b* of the second housing structure **520** that have mutually symmetrical shapes may form the second width W**2** of the recess. In an embodiment, the first portion **520***a* and the second portion **520***b* of the second housing structure **520** may have different distances from the folding axis A. The widths of the recess are not limited to the illustrated example. The recess may have a plurality of widths due to the form of the sensor area **524** or the asymmetrical portions of the first housing structure **510** and the second housing structure **520**.

At least a portion of the first housing structure **510** and at least a portion of the second housing structure **520** may be formed of a metallic material or a non-metallic material that has a stiffness selected to support the display **100**.

The sensor area **524** may be formed adjacent to one corner of the second housing structure **520** so as to have a predetermined area. However, the arrangement, shape, and size of the sensor area **524** are not limited to the illustrated example. For example, the sensor area **524** may be provided in another corner of the second housing structure **520** or in any area between an upper corner and a lower corner of the second housing structure **520**.

Components of the electronic device **10** may be exposed on the front surface of the electronic device **10** through the sensor area **524** or through one or more openings provided in the sensor area **524**. The components may include various types of sensors, e.g., a front camera, a receiver, and/or a proximity sensor.

The first back cover **580** is disposed on the rear surface of the electronic device **10** and located on one side of the folding axis A. For example, the first back cover **580** has a substantially rectangular periphery, which is surrounded by the first housing structure **510**. Similarly, the second back cover **590** is disposed on the rear surface of the electronic device **10** and is located on an opposite side of the folding axis A. The periphery of the second back cover **290** is surrounded by the second housing structure **520**.

The first back cover **580** and the second back cover **590** have substantially symmetrical shapes with respect to the folding axis A. However, the first back cover **580** and the second back cover **590** do not necessarily have to have mutually symmetrical shapes. Instead, the electronic device **10** may include the first back cover **580** and the second back cover **590** in various shapes.

Alternatively, the first back cover **580** may be integrally formed with the first housing structure **510**, and the second back cover **590** may be integrally formed with the second housing structure **520**.

The first back cover **580**, the second back cover **590**, the first housing structure **510**, and the second housing structure **520** form a space in which various components (e.g., a printed circuit board (PCB), a battery, etc.) of the electronic device **10** are disposed. One or more components may be disposed, or visually exposed, on the rear surface of the electronic device **10**. For example, at least a portion of a sub-display **190** may be visually exposed through a first rear area **582** of the first back cover **580**. One or more components or sensors may be visually exposed through a second rear area **592** of the second back cover **590**. The sensors may include a proximity sensor and/or a rear camera.

The electronic device **10** includes a heat-dissipation path structure **220** across the first housing structure **510** and the second housing structure **520**. For example, the heat-dissipation path structure **220** extends across the folding axis A in a direction (e.g., the X-axis direction) perpendicular to the folding axis A.

A portion of the heat-dissipation path structure **220** may be connected to a heat source **210**. For example, a heat dissipation member (e.g., a thermal interface material (TIM)) may be disposed between the portion of the heat-dissipation path structure **220** and the heat source **210**. The portion of the heat-dissipation path structure **220** may be connected with (or brought into contact with) one surface of the heat dissipation member. The heat source **210** may be connected with (or brought into contact with) an opposite surface that is opposite to the one surface of the heat dissipation member with which the heat-dissipation path structure **220** is brought into contact. The portion of the heat-dissipation path structure **220** may be directly connected with (or brought into direct contact with) the heat source **210**.

A portion of the heat-dissipation path structure **220** may be connected with (or brought into contact with) a heat pipe **230** that diffuses heat. The heat source **210** may be connected with one surface of the heat-dissipation path structure **220**, and the heat pipe **230** may be connected with (or brought into contact with) an opposite surface that is opposite to the one surface of the heat-dissipation path structure **220** with which the heat source **210** is connected.

Referring to FIG. **1**B, the hinge cover **530** is disposed between the first housing structure **510** and the second housing structure **520** and is configured to hide an internal part (e.g., a hinge structure). The hinge cover **530** may be hidden by a portion of the first housing structure **510** and a portion of the second housing structure **520**, or may be exposed to the outside, depending on a state (e.g., a flat state or a folded state) of the electronic device **10**.

For example, when the electronic device **10** is in a flat state as illustrated in FIG. **1**A, the hinge cover **530** may not be exposed as it is hidden by the first housing structure **510** and the second housing structure **520**. However, when the electronic device **10** is in a folded state (e.g., a fully folded state) as illustrated in FIG. **1**B, the hinge cover **530** is exposed to the outside from between the first housing structure **510** and the second housing structure **520**. When the electronic device **10** is in an intermediate state in which the first housing structure **510** and the second housing structure **520** are folded with a certain angle, i.e., not completely folded or unfolded, the hinge cover **530** may be partially exposed to the outside from between the first housing structure **510** and the second housing structure **520**. The hinge cover **530** may include a curved surface.

The display **100** is disposed in the space formed by the foldable housing **500**. For example, the display **100** is mounted in the recess formed by the foldable housing **500** and forms almost the entire front surface of the electronic device **10**.

The front surface of the electronic device **10** includes the display **100**, and a partial area of the first housing structure **510** and a partial area of the second housing structure **520** that are adjacent to the display **100**. The rear surface of the electronic device **10** includes the first back cover **580**, a partial area of the first housing structure **510** that is adjacent to the first back cover **580**, the second back cover **590**, and a partial area of the second housing structure **520** that is adjacent to the second back cover **590**.

The display **100** refers to a display, at least a partial area of which is capable of being deformed into a flat surface or a curved surface. For example, the display **100** includes a folding area **103**, a first area **101** disposed on one side of the folding area **103** (on the left side of the folding area **103** illustrated in FIG. **1**A), and a second area **102** disposed on an opposite side of the folding area **103** (on the right side of the folding area **103** illustrated in FIG. **1**A).

The division of the display **100** into the areas illustrated in FIG. **1**A is illustrative, and the display **100** may be divided into a plurality of areas (e.g., four or more areas, or two areas) depending on the structure or function of the display **100**. In FIG. **1**A, the areas of the display **100** are divided from each other by the folding area **103** or the folding axis A that extends parallel to the Y axis. Alternatively, the display **100** may be divided into areas with respect to another folding area (e.g., a folding area parallel to the X axis) or another folding axis (e.g., a folding axis parallel to the X axis).

The first area **101** and the second area **102** have shapes that are symmetrical to each other with respect to the folding area **103**. However, unlike the first area **101**, the second area **102** includes a notch that is cut for the sensor area **524**. Accordingly, the first area **101** and the second area **102** may include portions having symmetrical shapes and portions having asymmetrical shapes.

When the electronic device **10** is in a flat state (or unfolded state) as illustrated in FIG. **1**, the first housing structure **510** and the second housing structure **520** face the same direction while forming an angle of 180 degrees. Consequently, the surface of the first area **101** and the surface of the second area **102** of the display **100** face the same direction (e.g., the direction toward the front surface of the electronic device **10**) while forming an angle of 180 degrees. The folding area **103**, together with the first area **101** and the second area **102**, may form the same plane.

When the electronic device **10** is in a folded state as illustrated in FIG. **1**B, the first housing structure **510** and the second housing structure **520** face each other. The surface of the first area **101** and the surface of the second area **102** of the display **100** face each other while forming a narrow angle (e.g., an angle between 0 degrees and 10 degrees). At least a portion of the folding area **103** may be a curved surface having a predetermined curvature.

When the electronic device **10** is in an intermediate state between the flat state and the folded state, the first housing structure **510** and the second housing structure **520** may be disposed to form a certain angle. The surface of the first area **101** and the surface of the second area **102** of the display **100** may form an angle that is greater than that in the folded state and is smaller than that in the flat state. At least a portion of the folding area **103** may be a curved surface having a predetermined curvature, and the curvature may be smaller than that in the folded state.

FIG. **1**C illustrates an exploded perspective view of an electronic device according to an embodiment.

Referring to FIG. **1**C, the electronic device **10** includes a display unit **20**, a bracket assembly **30**, a circuit board **600**, the first housing structure **510**, the second housing structure **520**, the first back cover **580**, and the second back cover **590**. The display unit **20** may be referred to as a display module or a display assembly.

The display unit **20** includes the display **100** and one or more plates or layers **140** on which the display **140** is mounted. The plates **140** may be disposed between the display **100** and the bracket assembly **30**. The display **100** may be disposed on at least a portion of one surface of the plates **140** (e.g., the upper surface with respect to FIG. **1**C). The plates **140** may be formed in a shape corresponding to the display **100**. For example, partial areas of the plates **140** may be formed in a shape corresponding to a notch **104** of the display **100**.

The bracket assembly **30** includes a first bracket **410**, a second bracket **420**, a hinge structure **440** disposed between the first bracket **410** and the second bracket **420**, the hinge cover **530** that covers the hinge structure **440** when viewed from the outside, and a wiring member **430** (e.g., a flexible PCB (FPCB)) across the first bracket **410** and the second bracket **420**.

The bracket assembly **30** may be disposed between the plates **140** and the circuit board **600**. For example, the first bracket **410** may be disposed between the first area **101** of the display **100** and a first circuit board **610**. The second bracket **420** may be disposed between the second area **102** of the display **100** and a second circuit board **620**.

At least a portion of the wiring member **430** and at least a portion of the hinge structure **440** may be disposed inside the bracket assembly **30**. The wiring member **430** may be disposed in a direction (e.g., the X-axis direction) across the first bracket **410** and the second bracket **420**. The wiring member **430** may be disposed in a direction (e.g., the X-axis direction) that is perpendicular to a folding axis of the folding area **103** of the electronic device **10** (e.g., the Y axis or the folding axis A of FIG. **1**A).

The circuit board **600** includes the first circuit board **610** disposed near the first bracket **410** and the second circuit board **620** disposed near the second bracket **420**. The first circuit board **610** and the second circuit board **620** may be disposed in the space that is formed by the bracket assembly **30**, the first housing structure **510**, the second housing structure **520**, the first back cover **580**, and the second back cover **590**.

Components of the electronic device **10** may be mounted on the first circuit board **610** and the second circuit board **620**. For example, the heat source **210** (e.g., an AP, a CP, or a PMIC) that generates a relatively large amount of heat may be mounted on the second circuit board **620**. However, the arrangement, shape, and size of the heat source **210** are not limited to the illustrated example. The heat source **210** may be disposed on the first circuit board **610**, or may be disposed on both the first circuit board **610** and the second circuit board **620**.

The electronic device **10** include the heat-dissipation path structure **220** across the first bracket **410** and the second bracket **420**. For example, the heat-dissipation path structure **220** passes through the hinge structure **440** and may be connected with (or brought into contact with) the first bracket **410** and the second bracket **420**. The first bracket **410** may include a metal portion and an injection-molded portion. A portion of the heat-dissipation path structure **220** may be connected with the metal portion of the first bracket **410**. The second bracket **420** may include a metal portion and an injection-molded portion. A portion of the heat-dissipation path structure **220** may be connected with the metal portion of the second bracket **420**. The metal portion of the first bracket **410** or the metal portion of the second bracket **420** may serve as a heat sink.

A portion of the heat-dissipation path structure **220** may be connected to the heat source **210**. For example, a heat dissipation member (e.g., a TIM) may be disposed between the portion of the heat-dissipation path structure **220** and the heat source **210**. The portion of the heat-dissipation path structure **220** may be connected with one surface of the heat dissipation member. The heat source **210** may be connected with an opposite surface that is opposite to the one surface of the heat dissipation member with which the heat-dissipation path structure **220** is brought into contact. The portion of the heat-dissipation path structure **220** may be directly connected with the heat source **210**.

A portion of the heat-dissipation path structure **220** may be connected with the heat pipe **230** that diffuses heat. The heat source **210** may be connected with one surface of the heat-dissipation path structure **220**, and the heat pipe **230** may be connected with an opposite surface that is opposite to the one surface of the heat-dissipation path structure **220** with which the heat source **210** is connected.

The heat-dissipation path structure **220** may be disposed between the first bracket **410** and the second bracket **420** through a path that is the same as, or similar to, that of the wiring member **430**.

The first housing structure **510** and the second housing structure **520** may be assembled together and coupled to opposite sides of the bracket assembly **30** in a state in which the display unit **20** is coupled to the bracket assembly **30**. The first housing structure **510** and the second housing structure **520** may be coupled with the bracket assembly **30** by being slid on the opposite sides of the bracket assembly **30**.

The first housing structure **510** includes a first rotation support surface **512**, and the second housing structure **520** includes a second rotation support surface **522** corresponding to the first rotation support surface **512**. The first rotation support surface **512** and the second rotation support surface **522** may include a curved surface corresponding to a curved surface included in the hinge cover **530**.

When the electronic device **10** is in the flat state as illustrated in FIG. **1**A, the first rotation support surface **512** and the second rotation support surface **522** may cover the hinge cover **530** such that the hinge cover **530** is not exposed, or is minimally exposed, on the rear surface of the electronic device **10**. When the electronic device **10** is in the folded state as illustrated in FIG. **1**B, the first rotation support surface **512** and the second rotation support surface **522** may rotate along the curved surfaces included in the hinge cover **530** such that the hinge cover **530** is exposed on the rear surface of the electronic device **10**.

FIG. **2** illustrates a sectional view of the electronic device in FIG. **1**A taken along line B**1**-B**1**', according to an embodiment.

Referring to FIGS. **1**A, **1**C, and **2**, the electronic device **10** includes the first circuit board **610** disposed near the first bracket **410** and the second circuit board **620** disposed near the second bracket **420**. The first circuit board **610** is disposed between the first back cover **580** and the first bracket **410**. The second circuit board **620** is disposed between the second back cover **590** and the second bracket **420**. The electronic device **10** includes the wiring member **430** (e.g., an FPCB) across the first bracket **410** and the second bracket **420** through the hinge structure **440**. The wiring member **430** is connected with the first circuit board **610** through a first connector **431** and is connected with the second circuit board **620** through a second connector **432**.

Various components of the electronic device **10** may be mounted on the first circuit board **610** and the second circuit board **620**. For example, the heat source **210** (e.g., an AP, a CP, or a PMIC) that generates a relatively large amount of heat is mounted on the second circuit board **620**. However, the arrangement, shape, and size of the heat source **210** are not limited to the illustrated example. The heat source **210** may be disposed on the first circuit board **610**, or may be disposed on both the first circuit board **610** and the second circuit board **620**.

The electronic device **10** includes the heat-dissipation path structure **220** across the first bracket **410** and the second bracket **420**. For example, the heat-dissipation path structure **220** passes through the hinge structure **440** and is connected with (or brought into contact with) the first bracket **410** and the second bracket **420**. The first bracket **410** may include a metal portion and an injection-molded portion. A portion of the heat-dissipation path structure **220** may be connected with (or brought into contact with) the metal portion of the first bracket **410**. The second bracket **420** may include a metal portion and an injection-molded portion. A portion of the heat-dissipation path structure **220** may be connected with the metal portion of the second bracket **420**. The metal portion of the first bracket **410** or the metal portion of the second bracket **420** may serve as a heat sink.

A portion of the heat-dissipation path structure **220** may be connected to the heat source **210**. For example, a heat dissipation member **211** (e.g., a TIM) is disposed between the portion of the heat-dissipation path structure **220** and the heat source **210**. The portion of the heat-dissipation path structure **220** may be connected with one surface of the heat dissipation member **211**. The heat source **210** may be connected with an opposite surface that is opposite to the one surface of the heat dissipation member **211** with which the heat-dissipation path structure **220** is brought into contact. The portion of the heat-dissipation path structure **220** may be directly connected with (or brought into direct contact with) the heat source **210**.

A portion of the heat-dissipation path structure **220** may be connected with the heat pipe **230** that diffuses heat. The heat source **210** may be connected with one surface of the heat-dissipation path structure **220**, and the heat pipe **230** may be connected with an opposite surface that is opposite to the one surface of the heat-dissipation path structure **220** with which the heat source **210** is connected.

The heat-dissipation path structure **220** may be disposed between the first bracket **410** and the second bracket **420** through a path that is the same as, or similar to, that of the wiring member **430**.

The heat-dissipation path structure **220** may be formed in a layered structure including a plurality of layers. For example, the heat-dissipation path structure **220** may include a heat conduction layer formed of a material (e.g., graphite, copper, or the like) that has a relatively high heat transfer rate and one or more cover layers for maintaining the stiffness of the heat conduction layer. The cover layers may be disposed on the top and bottom of the heat conduction layer. The cover layers disposed on the top and bottom of the heat conduction layer may be disposed to surround the heat conduction layer in a sealed pouch form. The thicknesses of the cover layers may partially vary depending on a location on the heat-dissipation path structure **220**. In a portion of the heat-dissipation path structure **220** that corresponds to the hinge structure **440**, the cover layers may be thicker than in a portion of the heat-dissipation path structure **220** that corresponds to the first bracket **410** or the second bracket **420**. In the thicker portions of the cover layers, the cover layers may be constituted by a plurality of cover layers.

The heat-dissipation path structure **220** may diffuse, through the heat conduction layer, heat generated from the heat source **210**. On one side of the second bracket **420**, the heat-dissipation path structure **220** may diffuse the generated heat. For example, the generated heat is transferred to the heat-dissipation path structure **220** through the heat dissipation member **211**. The heat-dissipation path structure **220** diffuses the heat transferred from the heat source **210**. The heat-dissipation path structure **220** may transfer the transferred heat to the heat pipe **230**. On one side of the second bracket **420**, the heat pipe **230** may diffuse the transferred heat. The heat-dissipation path structure **220** may diffuse the transferred heat through the metal portion of the second bracket **420**.

The heat-dissipation path structure **220** may diffuse the transferred heat toward the first bracket **410**. For example, the heat-dissipation path structure **220** diffuses the transferred heat toward the first bracket **410** through the hinge structure **440**. The heat-dissipation path structure **220** may diffuse the transferred heat through the metal portion of the first bracket **410**.

As described above, the electronic device **10** may diffuse the heat generated from the heat source **210**, i.e., a component that is located near the second bracket **420**, toward the first bracket **410** through the heat-dissipation path structure **220**, and the heat dissipation performance of the electronic device **10** may be improved.

FIG. **3** illustrates an electronic device according to an embodiment. FIG. **4**A illustrates a sectional view of the electronic device in FIG. **3** taken along line B**2**-B**2'**, according to an embodiment. FIG. **4**B illustrates a sectional view of the electronic device in FIG. **3** taken along line B**3**-B**3'**, according to an embodiment.

Referring to FIGS. **3**, **4**A, and **4**B, an electronic device **101** includes a rollable display **100_1**. Reference numeral **301** represents a closed state of the electronic device **10_1**, and reference numeral **302** represents an open state of the electronic device **10_1**.

The electronic device **10_1** includes a first housing structure **510_1**, a second housing structure **520_1**, and the rollable display **100_1** that is disposed in a space formed by the first housing structure **510_1** and the second housing structure **520_1**. In the closed state **301** of the electronic device **10_1**, the display **100_1** may be folded or rolled up and may be stored (or received) in the space formed by the first housing structure **501_1** and the second housing structure **520_1**. In the open state **302** of the electronic device **10_1**, the display **100_1** may be unfolded or unrolled and may display a screen.

The display **100_1** includes a first area **101_1** fixed to the first housing structure **510_1**, a second area **102_1** fixed to the second housing structure **520_1**, and a rolling area **103_1** located between the first area **101_1** and the second area **102_1**. In the closed state **301**, the rolling area **103_1** may be stored (or received) in the space formed by the first housing structure **510_1** and the second housing structure **520_1**, and in the open state **302**, the rolling area **103_1** may be exposed to the outside.

The first housing structure **510_1** includes a first circuit board **610_1** disposed near a first bracket **410_1**. The second housing structure **520_1** includes a second circuit board **620_1** disposed near a second bracket **420_1**. At least a portion of the first housing structure **510_1** and at least a portion of the second housing structure **520_1** may be formed of a metallic material or a non-metallic material that has a stiffness selected to support the display **100_1**. A portion of the display **100_1** may be connected to the first circuit board **610_1** through a first display connector **110_1**. Another portion of the display **100_1** may be connected to the second circuit board **620_1** through a second display connector **120_1**.

Various components of the electronic device **10_1** may be mounted on the first circuit board **610_1** and the second circuit board **620_1**. For example, a heat source **210_1** (e.g., an AP, a CP, or a PMIC) that generates a relatively large amount of heat is mounted on the first circuit board **610_1**. However, the arrangement, shape, and size of the heat source **210_1** are not limited to the illustrated example. For example, the heat source **210_1** may be disposed on the second circuit board **620_1**, or may be disposed on both the first circuit board **610_1** and the second circuit board **620_1**.

The electronic device **10_1** includes a heat-dissipation path structure **220_1** across the first housing structure **510_1**, the display **100_1**, and the second housing structure **520_1**. For example, the electronic device **10_1** includes the heat-dissipation path structure **220_1** extending from the first bracket **410_1** to the second bracket **420_1** (or from the second bracket **420_1** to the first bracket **410_1**). For example, the heat-dissipation path structure **220_1** extends along the display **100_1** and may be connected with (or brought into contact with) the first bracket **410_1** and the second bracket **420_1**. The first bracket **410_1** may include a metal portion and an injection-molded portion. A portion of the heat-dissipation path structure **220_1** may be connected with the metal portion of the first bracket **410_1**. The second bracket **420_1** may include a metal portion and an injection-molded portion. A portion of the heat-dissipation path structure **220_1** may be connected with the metal portion of the second bracket **420_1**. The metal portion of the first bracket **410_1** or the metal portion of the second bracket **420_1** may serve as a heat sink. In the closed state **301**, the heat-dissipation path structure **220_1** may be folded or rolled up in a form (or way) that is the same as, or similar to, that of the display **100_1**.

A portion of the heat-dissipation path structure **220_1** may be connected to the heat source **210_1**. For example, a heat dissipation member **211_1** (e.g., a TIM) is disposed between the portion of the heat-dissipation path structure **220_1** and the heat source **210_1**. The portion of the heat-dissipation path structure **220-1** may be connected with (or brought into contact with) one surface of the heat dissipation member **211_1**. The heat source **210_1** may be connected with an opposite surface that is opposite to the one surface of the heat dissipation member **211_1** with which the heat-dissipation path structure **220_1** is brought into contact. The portion of the heat-dissipation path structure **220_1** may be directly connected with the heat source **210_1**.

A portion of the heat-dissipation path structure **220_1** may be connected with a heat pipe **230_1** that diffuses heat. The heat source **210_1** may be connected with one surface of the heat-dissipation path structure **220_1**, and the heat pipe **230_1** may be connected with an opposite surface that is opposite to the one surface of the heat-dissipation path structure **220_1** with which the heat source **210_1** is connected.

The heat-dissipation path structure **220_1** may be formed in a layered structure including a plurality of layers. For example, the heat-dissipation path structure **220_1** may include a heat conduction layer formed of a material (e.g., graphite, copper, or the like) that has a relatively high heat transfer rate and one or more cover layers for maintaining the stiffness of the heat conduction layer. The cover layers may be disposed on the top and bottom of the heat conduction layer. The cover layers disposed on the top and bottom of the heat conduction layer may be disposed to surround the heat conduction layer in a sealed pouch form. The thicknesses of the cover layers may partially vary depending on a location on the heat-dissipation path structure **220_1**. In a portion of the heat-dissipation path structure **220_1** that corresponds to the display **100_1**, the cover layers may be thicker than in a portion of the heat-dissipation path structure **220_1** that corresponds to the first bracket **410_1** or the second bracket **420_1**. In the thicker portions of the cover layers, the cover layers may be constituted by a plurality of cover layers.

The heat-dissipation path structure **220_1** may diffuse, through the heat conduction layer, heat generated from the heat source **210_1**. On one side of the first bracket **410_1**, the heat-dissipation path structure **220_1** may diffuse the generated heat. For example, the generated heat may be transferred to the heat-dissipation path structure **220_1** through the heat dissipation member **211_1**. The heat-dissipation path structure **220_1** may diffuse the heat transferred from the heat source **210_1**. The heat-dissipation path structure **220_1** may transfer the transferred heat to the heat pipe **230_1**. On one side of the first bracket **410_1**, the heat pipe **230_1** may diffuse the transferred heat. The heat-dissipation path structure **220_1** may diffuse the transferred heat through the metal portion of the first bracket **410_1**.

The heat-dissipation path structure **220_1** may diffuse the transferred heat toward the second bracket **420_1**. For example, the heat-dissipation path structure **220_1** may diffuse the transferred heat toward the second bracket **420_1** along the display **100_1**. The heat-dissipation path structure **220_1** may diffuse the transferred heat through the metal portion of the second bracket **420_1**.

As described above, the electronic device **10_1** may diffuse the heat generated from the heat source **210_1**, which is located near the first bracket **410_1**, toward the second bracket **420_1** through the heat-dissipation path structure **220_1**, and the heat dissipation performance of the electronic device **101** may be improved.

FIG. **5** illustrates a heat-dissipation path structure according to an embodiment. For example, the heat-dissipation path structure **220** of FIG. **1**A may be embodied as illustrated in FIG. **5**.

Referring to FIG. **5**, the heat-dissipation path structure includes a first structural portion **2201**, a second structural portion **2202**, and a third structural portion **2203**. However, the portions of the heat-dissipation path structure are not limited to the illustrated example of three.

The first structural portion **2201** may be disposed in a first housing portion of an electronic device. The second structural portion **2202** may be disposed through a hinge portion of the electronic device or along a display portion of the electronic device. The third structural portion **2203** may be disposed in a second housing portion of the electronic device. The heat-dissipation path structure may be disposed throughout the first housing portion, the hinge portion (or the display portion), and the second housing portion, and the second structural portion **2202** may be disposed through the hinge portion (or along the display portion).

The first structural portion **2201** may be connected to the heat source **210**. For example, the first structural portion **2201** is connected to the heat source **210** through the heat dissipation member **211**. One surface of the first structural portion **2201** may be brought into contact with the heat dissipation member **211**. One surface of the heat dissipation member **211** may be brought into contact with the heat source **210**.

The heat-dissipation path structure is constituted by a plurality of layers. For example, the heat-dissipation path structure includes a heat conduction layer **221**, a first cover layer **222** formed (or deposited) on one surface of the heat conduction layer **221**, and a second cover layer **223** formed (or deposited) on an opposite surface of the heat conduction layer **221**.

The heat conduction layer **221**, the first cover layer **222**, or the second cover layer **223** may have a uniform thickness over the first to third structural portions **2201** to **2203**. The first cover layer **222** and the second cover layer **223** may have different thicknesses. Alternatively, the first cover layer **222** and the second cover layer **223** may have the same thickness. For example, the first cover layer **222** and the second cover layer **223** may have a first specific thickness (e.g., about 5 μm). The first specific thickness may be determined in consideration of the heat transfer rate between the heat source **210** and the heat conduction layer **221**. Alternatively, the first specific thickness may be determined in consideration of the heat transfer rate between a heat sink and the heat conduction layer **221**.

The second structural portion **2202** may have a different thickness from the first structural portion **2201** or the third structural portion **2203**. For example, the second structural portion **2202** may be thicker than the first structural portion **2201** or the third structural portion **2203**. An additional cover layer may be formed (or stacked) in the second structural portion **2202**. For example, in the second structural portion **2202**, the heat conduction layer **221** may be formed (or stacked) on one surface of the first cover layer **222**, and a third cover layer **224** may be formed on an opposite surface of the first cover layer **222**.

In the second structural portion **2202**, the heat conduction layer **221** may be formed on one surface of the second cover layer **223**, and a fourth cover layer **225** may be formed on an opposite surface of the second cover layer **223**. The third cover layer **224** and the fourth cover layer **225** may have different thicknesses. Alternatively, the third cover layer **224** and the fourth cover layer **225** may have the same thickness. For example, the third cover layer **224** and the fourth cover layer **225** may be thicker than the first cover layer **222** and the second cover layer **223**. The third cover layer **224** and the fourth cover layer **225** may have a second specific thickness (e.g., about 50 μm) that is greater than the first specific thickness. The second specific thickness may be determined in consideration of the durability or flexibility based on a movement of the hinge portion.

The heat conduction layer **221** may be formed of graphite or copper. The first to fourth cover layers **222** to **225** may be formed of a polymer compound (e.g., polyethylene terephthalate (PET)). The first cover layer **222** and the second cover layer **223** may be formed of a polymer compound having a higher thermal conductivity than the third cover layer **224** and the fourth cover layer **225**. The third cover layer **224** and the fourth cover layer **225** may be formed of a polymer compound having a higher durability or flexibility than the first cover layer **222** and the second cover layer **223**.

The first cover layer **222** and the second cover layer **223** may be disposed to surround the heat conduction layer **221** in a pouch form at opposite ends **228** and **229** of the heat-dissipation path structure.

The first structural portion **2201** may be connected with (or brought into contact with) a first heat sink that is included in the first housing portion. The first structural portion **2201** may be connected with a heat pipe that is included in the first housing portion. The third structural portion **2203** may be connected with a second heat sink that is included in the second housing portion.

FIG. **6** illustrates a sectional view of a heat-dissipation path structure according to an embodiment. For example, the heat-dissipation path structure **220** of FIG. **1**A may be embodied as illustrated in FIG. **6**.

Referring to FIG. **6**, the heat-dissipation path structure includes a first structural portion **2201**, a second structural portion **2202**, and a third structural portion **2203**. However, the portions of the heat-dissipation path structure are not limited to the illustrated example of three.

The arrangement of the first structural portion **2201**, the second structural portion **2202**, and the third structural portion **2203** in an electronic device is the same as, or similar to, the arrangement described above with reference to FIG. **5**. Therefore, a repetitive description of these portion is omitted below.

The heat-dissipation path structure is constituted by a plurality of layers. For example, the heat-dissipation path structure **220** includes a heat conduction layer **221**, which may have a uniform thickness over the first to third structural portions **2201** to **2203**.

In the first structural portion **2201**, a first cover layer **222** is formed (or deposited) on one surface of the heat conduction layer **221** and a second cover layer **223** is formed on an opposite surface of the heat conduction layer **221**. For example, the first cover layer **222** and the second cover layer **223** may have different thicknesses. Alternatively, the first cover layer **222** and the second cover layer **223** may have the same thickness. For example, the first cover layer **222** and the second cover layer **223** may have a first specific thickness (e.g., about 5 μm). The first specific thickness may be determined in consideration of the heat transfer rate between the heat source **210** and the heat conduction layer **221**. Alternatively, the first specific thickness may be determined in consideration of the heat transfer rate between a first heat sink and the heat conduction layer **221**.

In the second structural portion **2202**, a third cover layer **224** is formed on the one surface of the heat conduction layer **221** and a fourth cover layer **225** is formed on the opposite surface of the heat conduction layer **221**. For example, the third cover layer **224** and the fourth cover layer **225** may have different thicknesses. Alternatively, the third cover layer **224** and the fourth cover layer **225** may have the same thickness. For example, the third cover layer **224** and the fourth cover layer **225** may be thicker than the first cover layer **222** or the second cover layer **223**. The third cover layer **224** and the fourth cover layer **225** may have a second specific thickness (e.g., about 50 μm) that is greater than the first specific thickness. The second specific thickness may be determined in consideration of the durability or flexibility based on a movement of a hinge portion.

In the third structural portion **2203**, a fifth cover layer **226** is formed on the one surface of the heat conduction layer **221** and a sixth cover layer **227** is formed on the opposite surface of the heat conduction layer **221**. For example, the fifth cover layer **226** and the sixth cover layer **227** may have different thicknesses. Alternatively, the fifth cover **1***o* layer **226** and the sixth cover layer **227** may have the same thickness. For example, the fifth cover layer **226** and the sixth cover layer **227** may have a third specific thickness (e.g., about 5 μm). The third specific thickness may be determined in consideration of the heat transfer rate between a second heat sink and the heat conduction layer **221**.

The heat conduction layer **221** may be formed of graphite or copper. The first to sixth cover layers **222** to **227** may be formed of a polymer compound. For example, the first cover layer **222**, the second cover layer **223**, the fifth cover layer **226**, and the sixth cover layer **227** may be formed of a polymer compound having a higher thermal conductivity than the third cover layer **224** and the fourth cover layer **225**. The third cover layer **224** and the fourth cover layer **225** may be formed of a polymer compound having a higher durability or flexibility than the first cover layer **222**, the second cover layer **223**, the fifth cover layer **226**, and the sixth cover layer **227**.

The first cover layer **222** and the second cover layer **223** may be disposed to surround the heat conduction layer **221** in a pouch form at one end **228** of the heat-dissipation path structure. The fifth cover layer **226** and the sixth cover layer **227** may be disposed to surround the heat conduction layer **221** in a pouch form at an opposite end **229** of the heat-dissipation path structure.

FIG. **7** illustrates a sectional view of a heat-dissipation path structure according to an embodiment. For example, the heat-dissipation path structure **220** of FIG. **1**A may be embodied as illustrated in FIG. **7**.

Referring to FIG. **7**, the heat-dissipation path structure includes a first structural portion **2201**, a second structural portion **2202**, and a third structural portion **2203**. However, the portions of the heat-dissipation path structure are not limited to the illustrated example of three.

As the arrangement of the first structural portion **2201**, the second structural portion **2202**, and the third structural portion **2203** in an electronic device is the same as, or similar to, the arrangement described above with reference to FIG. **5**, a repetitive description thereabout will be omitted below.

The heat-dissipation path structure may be constituted by an FPCB including a plurality of layers. For example, the heat-dissipation path structure includes a heat conduction layer **221**. The heat conduction layer **221** may include at least one conductive layer. The heat conduction layer **221** may have a uniform thickness over the first to third structural portions **2201** to **2203**. The heat-dissipation path structure includes a dielectric layer **710** surrounding the heat conduction layer **221**.

The heat-dissipation path structure may have partially different thicknesses. For example, in the first structural portion **2201**, the dielectric layer **710** may include a first step portion **711** and a second step portion **712**. In the third structural portion **2203**, the dielectric layer **710** includes a third step portion **713**. The first step portion **711**, the second step portion **712**, and the third step portion **713** may be formed by removing portions of the FPCB having a specific thickness through a cutting process.

The dielectric layer **710** corresponding to the first step portion **711**, the dielectric layer **710** corresponding to the second step portion **712**, and the dielectric layer **710** corresponding to the third step portion **713** may have different thicknesses. Alternatively, the dielectric layer **710** corresponding to the first step portion **711**, the dielectric layer **710** corresponding to the second step portion **712**, and the dielectric layer **710** corresponding to the third step portion **713** may have the same thickness (e.g., about 5 μm).

The second structural portion **2202** may have the thicker dielectric layer **710** than the first structural portion **2201** or the third structural portion **2203**, and thus the durability or flexibility may be improved. For example, in the remaining portion other than the first step portion **711**, the second step portion **712**, and the third step portion **713**, the dielectric layer **710** may have a specific thickness (e.g., about 50 μm) by stacking FPCBs.

The first step portion **711**, the second step portion **712**, and the third step portion **713** may have different widths. For example, the first step portion **711** may be formed based on the size of the heat source **210**. The second step portion **712** may be formed based on the size of a first heat sink. The third step portion **713** may be formed based on the size of a second heat sink.

The dielectric layer **710** may be formed to surround the heat conduction layer **221** in a pouch form at opposite ends **714** and **715** of the heat-dissipation path structure.

FIG. **8** illustrates a slit structure formed in a heat-dissipation path structure according to an embodiment. For example, the heat-dissipation path structure **220** of FIG. **1**A may be embodied as illustrated in FIG. **8**.

Referring to FIG. **8**, the heat-dissipation path structure is the same as, or similar to, the heat-dissipation path structure of FIG. **5**, except for a slit structure **801** that is added thereto. The slit structure **801** may also be applied to the heat-dissipation path structure of FIG. **6**.

The heat-dissipation path structure includes the slit structure **801** formed in a second structural portion **2202** in the X-axis direction (e.g., the direction perpendicular to the folding axis A in FIG. **1**A). For example, the slit structure **801** is formed in a heat conduction layer **221**. A first cover layer **222** and a second cover layer **223** are attached to the heat conduction layer **221** through an adhesive member **802**. When the first cover layer **222** and the second cover layer **223** are attached, the slit structure **801** may be filled with the adhesive member **802**. Accordingly, when compared with the heat-dissipation path structure in which the slit structure **801** is not present, the first cover layer **222** and the second cover layer **223** are more firmly coupled (or attached) to the heat conduction layer **221**, the stiffness of the heat-dissipation path structure in the second structural portion **2202** may be increased, and a possibility of separation of the cover layer (e.g., the first cover layer **222** or the second cover layer **223**) by a movement of a hinge portion may be lowered.

FIG. **9** illustrates a dot structure formed in a heat-dissipation path structure according to an embodiment. For example, the heat-dissipation path structure **220** of FIG. **1**A may be embodied as illustrated in FIG. **9**.

Referring to FIG. **9**, the heat-dissipation path structure is the same as, or similar to, the heat-dissipation path structure of FIG. **5**, except for dot structures **901** that are added thereto. The dot structure **901** may also be applied to the heat-dissipation path structure of FIG. **6**.

The heat-dissipation path structure includes a plurality of dot structures **901** formed in a second structural portion **2202**. For example, the dot structures **901** are formed in a heat conduction layer **221**. A first cover layer **222** and a second cover layer **223** are attached to the heat conduction layer **221** through an adhesive member **902**. When the first cover layer **222** and the second cover layer **223** are attached, the dot structures **901** may be filled with the adhesive member **902**. Accordingly, when compared with a heat-dissipation path structure in which the dot structures **901** are not present, the first cover layer **222** and the second cover layer **223** may be more firmly coupled (or attached) to the heat conduction layer **221**, the stiffness of the heat-dissipation path structure **220** in the second structural portion **2202** may be increased, and a possibility of separation of the cover layer (e.g., the first cover layer **222** or the second cover layer **223**) by a movement of a hinge portion may be lowered.

FIG. **10** illustrates an electronic device **1001** in a network environment **1000** according to an embodiment.

Referring to FIG. **10**, the electronic device **1001** in the network environment **1000** may communicate with an electronic device **1002** via a first network **1098** (e.g., a short-range wireless communication network), or an electronic device **1004** or a server **1008** via a second network **1099** (e.g., a long-range wireless communication network). According to an embodiment, the electronic device **1001** may communicate with the electronic device **1004** via the server **1008**. According to an embodiment, the electronic device **1001** may include a processor **1020**, memory **1030**, an input device **1050**, a sound output device **1055**, a display device **1060**, an audio module **1070**, a sensor module **1076**, an interface **1077**, a haptic module **1079**, a camera module **1080**, a power management module **1088**, a battery **1089**, a communication module **1090**, a subscriber identification module (SIM) **1096**, or an antenna module **1097**. In some embodiments, at least one (e.g., the display device **1060** or the camera module **1080**) of the components may be omitted from the electronic device **1001**, or one or more other components may be added in the electronic device **1001**. In some embodiments, some of the components may be implemented as single integrated circuitry. For example, the sensor module **1076** (e.g., a fingerprint sensor, an iris sensor, or an illuminance sensor) may be implemented as embedded in the display device **1060** (e.g., a display).

The processor **1020** may execute, for example, software (e.g., a program **1040**) to control at least one other component (e.g., a hardware or software component) of the electronic device **1001** coupled with the processor **1020**, and may perform various data processing or computation. According to one embodiment, as at least part of the data processing or computation, the processor **1020** may load a command or data received from another component (e.g., the sensor module **1076** or the communication module **1090**) in volatile memory **1032**, process the command or the data stored in the volatile memory **1032**, and store resulting data in non-volatile memory **1034**. According to an embodiment, the processor **1020** may include a main processor **1021** (e.g., a central processing unit (CPU) or an AP), and an auxiliary processor **1023** (e.g., a graphics processing unit (GPU), an image signal processor (ISP), a sensor hub processor, or a CP) that is operable independently from, or in conjunction with, the main processor **1021**. Additionally or alternatively, the auxiliary processor **1023** may be adapted to consume less power than the main processor **1021**, or to be specific to a specified function. The auxiliary processor **1023** may be implemented as separate from, or as part of the main processor **1021**.

The auxiliary processor **1023** may control at least some of functions or states related to at least one component (e.g., the display device **1060**, the sensor module **1076**, or the communication module **1090**) among the components of the electronic device **1001**, instead of the main processor **1021** while the main processor **1021** is in an inactive (e.g., sleep) state, or together with the main processor **1021** while the main processor **1021** is in an active state (e.g., executing an application). According to an embodiment, the auxiliary processor **1023** (e.g., an ISP or a CP) may be implemented as part of another component (e.g., the camera module **1080** or the communication module **1090**) functionally related to the auxiliary processor **1023**.

The memory **1030** may store various data used by at least one component (e.g., the processor **1020** or the sensor module **1076**) of the electronic device **1001**. The various data may include, for example, software (e.g., the program **1040**) and input data or output data for a command related thereto. The memory **1030** may include the volatile memory **1032** or the non-volatile memory **1034**.

The program **1040** may be stored in the memory **1030** as software, and may include, for example, an operating system (OS) **1042**, middleware **1044**, or an application **1046**.

The input device **1050** may receive a command or data to be used by other component (e.g., the processor **1020**) of the electronic device **1001**, from the outside (e.g., a user) of the electronic device **1001**. The input device **1050** may include, for example, a microphone, a mouse, a keyboard, or a digital pen (e.g., a stylus pen).

The sound output device **1055** may output sound signals to the outside of the electronic device **1001**. The sound output device **1055** may include, for example, a speaker or a receiver. The speaker may be used for general purposes, such as playing multimedia or playing record, and the receiver may be used for an incoming calls. According to an embodiment, the receiver may be implemented as separate from, or as part of the speaker.

The display device **1060** may visually provide information to the outside (e.g., a user) of the electronic device **1001**. The display device **1060** may include, for example, a display, a hologram device, or a projector and control circuitry to control a corresponding one of the display, hologram device, and projector. According to an embodiment, the display device **1060** may include touch circuitry adapted to detect a touch, or sensor circuitry (e.g., a pressure sensor) adapted to measure the intensity of force incurred by the touch.

The audio module **1070** may convert a sound into an electrical signal and vice versa. According to an embodiment, the audio module **1070** may obtain the sound via the input device **1050**, or output the sound via the sound output device **1055** or a headphone of an external electronic device (e.g., an electronic device **1002**) directly (e.g., wiredly) or wirelessly coupled with the electronic device **1001**.

The sensor module **1076** may detect an operational state (e.g., power or temperature) of the electronic device **1001** or an environmental state (e.g., a state of a user) external to the electronic device **1001**, and then generate an electrical signal or data value corresponding to the detected state. According to an embodiment, the sensor module **1076** may include, for example, a gesture sensor, a gyro sensor, an atmospheric pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a proximity sensor, a color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor.

The interface **1077** may support one or more specified protocols to be used for the electronic device **1001** to be coupled with the external electronic device (e.g., the electronic device **1002**) directly (e.g., wiredly) or wirelessly. According to an embodiment, the interface **1077** may include, for example, a high definition multimedia interface (HDMI), a universal serial bus (USB) interface, a secure digital (SD) card interface, or an audio interface.

A connecting terminal **1078** may include a connector via which the electronic device **1001** may be physically connected with the external electronic device (e.g., the electronic device **1002**). According to an embodiment, the connecting terminal **1078** may include, for example, an HDMI connector, a USB connector, an SD card connector, or an audio connector (e.g., a headphone connector).

The haptic module **1079** may convert an electrical signal into a mechanical stimulus (e.g., a vibration or a movement) or electrical stimulus which may be recognized **1***o* by a user via his tactile sensation or kinesthetic sensation. According to an embodiment, the haptic module **1079** may include, for example, a motor, a piezoelectric element, or an electric stimulator.

The camera module **1080** may capture a still image or moving images. According to an embodiment, the camera module **1080** may include one or more lenses, image sensors, ISPs, or flashes.

The power management module **1088** may manage power supplied to the electronic device **1001**. According to one embodiment, the power management module **1088** may be implemented as at least part of, for example, a PMIC.

The battery **1089** may supply power to at least one component of the electronic device **1001**. According to an embodiment, the battery **1089** may include, for example, a primary cell which is not rechargeable, a secondary cell which is rechargeable, or a fuel cell.

The communication module **1090** may support establishing a direct (e.g., wired) communication channel or a wireless communication channel between the electronic device **1001** and the external electronic device (e.g., the electronic device **1002**, the electronic device **1004**, or the server **1008**) and performing communication via the established communication channel. The communication module **1090** may include one or more CPs that are operable independently from the processor **1020** (e.g., the AP) and supports a direct (e.g., wired) communication or a wireless communication. According to an embodiment, the communication module **1090** may include a wireless communication module **1092** (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation satellite system (GNSS) communication module) or a wired communication module **1094** (e.g., a local area network (LAN) communication module or a power line communication (PLC) module). A corresponding one of these communication modules may communicate with the external electronic device via the first network **1098** (e.g., a short-range communication network, such as Bluetooth™, wireless-fidelity (Wi-Fi) direct, or infrared data association (IrDA)) or the second network **1099** (e.g., a long-range communication network, such as a cellular network, the Internet, or a computer network (e.g., LAN or wide area network (WAN)). These various types of communication modules may be implemented as a single component (e.g., a single chip), or may be implemented as multi components (e.g., multi chips) separate from each other. The wireless communication module **1092** may identify and authenticate the electronic device **1001** in a communication network, such as the first network **1098** or the second network **1099**, using subscriber information (e.g., international mobile subscriber identity (IMSI)) stored in the subscriber identification module **1096**.

The antenna module **1097** may transmit or receive a signal or power to or from the outside (e.g., the external electronic device) of the electronic device **1001**. According to an embodiment, the antenna module **1097** may include an antenna including a radiating element composed of a conductive material or a conductive pattern formed in or on a substrate (e.g., a PCB). According to an embodiment, the antenna module **1097** may include a plurality of antennas. In such a case, at least one antenna appropriate for a communication scheme used in the communication network, such as the first network **1098** or the second network **1099**, may be selected, for example, by the communication module **1090** (e.g., the wireless communication module **1092**) from the plurality of antennas. The signal or the power may then be transmitted or received between the communication module **1090** and the external electronic device via the selected at least one antenna. According to an embodiment, another component (e.g., a radio frequency integrated circuit (RFIC)) other than the radiating element may be additionally formed as part of the antenna module **1097**.

At least some of the above-described components may be coupled mutually and communicate signals (e.g., commands or data) therebetween via an inter-peripheral communication scheme (e.g., a bus, general purpose input and output (GPIO), serial peripheral interface (SPI), or mobile industry processor interface (MIPI)).

According to an embodiment, commands or data may be transmitted or received between the electronic device **1001** and the external electronic device **1004** via the server **1008** coupled with the second network **1099**. Each of the electronic devices **1002** and **1004** may be a device of a same type as, or a different type, from the electronic device **1001**. According to an embodiment, all or some of operations to be executed at the electronic device **1001** may be executed at one or more of the external electronic devices **1002**, **1004**, or **1008**. For example, if the electronic device **1001** should perform a function or a service automatically, or in response to a request from a user or another device, the electronic device **1001**, instead of, or in addition to, executing the function or the service, may request the one or more external electronic devices to perform at least part of the function or the service. The one or more external electronic devices receiving the request may perform the at least part of the function or the service requested, or an additional function or an additional service related to the request, and transfer an outcome of the performing to the electronic device **1001**. The electronic device **1001** may provide the outcome, with or without further processing of the outcome, as at least part of a reply to the request. To that end, a cloud computing, distributed computing, or client-server computing technology may be used, for example.

The electronic device according to various embodiments may be one of various types of electronic devices. The electronic devices may include, for example, a portable communication device (e.g., a smartphone), a computer device, a portable multimedia device, a portable medical device, a camera, a wearable device, or a home appliance. According to an embodiment of the disclosure, the electronic devices are not limited to those described above.

It should be appreciated that various embodiments of the disclosure and the terms used therein are not intended to limit the technological features set forth herein to particular embodiments and include various changes, equivalents, or replacements for a corresponding embodiment. With regard to the description of the drawings, similar reference numerals may be used to refer to similar or related elements. It is to be understood that a singular form of a noun corresponding to an item may include one or more of the things, unless the relevant context clearly indicates otherwise. As used herein, each of such phrases as "A or B," "at least one of A and B," "at least one of A or B," "A, B, or C," "at least one of A, B, and C," and "at least one of A, B, or C," may include any one of, or all possible combinations of the items enumerated together in a corresponding one of the phrases. As used herein, such terms as "1st" and "2nd," or "first" and "second" may be used to simply distinguish a corresponding component from another, and does not limit the components in other aspect (e.g., importance or order). It is to be understood that if an element (e.g., a first element) is referred to, with or without the term "operatively" or "communicatively", as "coupled with," "coupled to," "connected with," or "connected to" another element (e.g., a second element), it means that the element may be coupled with the other element directly (e.g., wiredly), wirelessly, or via a third element.

As used herein, the term "module" may include a unit implemented in hardware, software, or firmware, and may interchangeably be used with other terms, for example, "logic," "logic block," "part," or "circuitry". A module may be a single integral component, or a minimum unit or part thereof, adapted to perform one or more functions. For example, according to an embodiment, the module may be implemented in a form of an application-specific integrated circuit (ASIC).

Various embodiments as set forth herein may be implemented as software (e.g., the program **1040**) including one or more instructions that are stored in a storage medium (e.g., internal memory **1036** or external memory **1038**) that is readable by a machine (e.g., the electronic device **1001**). For example, a processor (e.g., the processor **1020**) of the machine (e.g., the electronic device **1001**) may invoke at least one of the one or more instructions stored in the storage medium, and execute it, with or without using one or more other components under the control of the processor. This allows the machine to be operated to perform at least one function according to the at least one instruction invoked. The one or more instructions may include a code generated by a compiler or a code executable by an interpreter. The machine-readable storage medium may be provided in the form of a non-transitory storage medium. Wherein, the term "non-transitory storage medium" means a tangible device, and does not include a signal (e.g., an electromagnetic wave), but this term does not differentiate between where data is semi-permanently stored in the storage medium and where the data is temporarily stored in the storage medium. For example, "the non-transitory storage medium" may include a buffer where data is temporally stored.

A method according to various embodiments of the disclosure may be included and provided in a computer program product. The computer program product may be traded as a product between a seller and a buyer. The computer program product (e.g., downloadable app)) may be distributed in the form of a machine-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or be distributed (e.g., downloaded or uploaded) online via an application store (e.g., PlayStore™), or between two user devices (e.g., smart phones) directly. If distributed online, at least part of the computer program product may be temporarily generated or at least temporarily stored in the machine-readable storage medium, such as memory of the manufacturer's server, a server of the application store, or a relay server.

According to various embodiments, each component (e.g., a module or a program) of the above-described components may include a single entity or multiple entities. According to various embodiments, one or more of the above-described components may be omitted, or one or more other components may be added. Alternatively or additionally, a plurality of components (e.g., modules or programs) may be integrated into a single component. In such a case, according to various embodiments, the integrated component may still perform one or more functions of each of the plurality of components in the same or similar manner as they are performed by a corresponding one of the plurality of components before the integration. According to various embodiments, operations performed by the module, the program, or another component may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

According to the above-described embodiments, a heat dissipation operation may be rapidly performed by using a space of the flexible display device, performance degradation of the flexible display device due to heat generation may be prevented, and an unpleasant feeling and a low-temperature burn of a user may be prevented through rapid heat dissipation.

In addition, the disclosure may provide various effects that are directly or indirectly recognized.

While the disclosure has been shown and described with reference to various embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the disclosure as defined by the appended claims and their equivalents.

What is claimed is:

1. A flexible display device, comprising:

a first housing;

a second housing;

a hinge structure configured to connect the first housing and the second housing and support a hinge motion of the first housing or the second housing;

a heat source disposed in the first housing;

a heat sink disposed in the second housing; and

a heat-dissipation path structure disposed across the first housing, the hinge structure, and the second housing,

wherein the heat-dissipation path structure transfers heat generated by the heat source to the heat sink, and

wherein a first portion of the heat-dissipation path structure corresponding to the hinge structure has a different thickness than a second portion of the heat-dissipation path structure corresponding to the first housing or the second housing.

2. The flexible display device of claim **1**, wherein at least a portion of the heat-dissipation path structure is disposed to pass through at least a portion of the hinge structure.

3. The flexible display device of claim **1**, wherein the heat-dissipation path structure comprises:

a heat conduction layer that transfers the heat generated by the heat source; and

a cover layer that surrounds the heat conduction layer.

4. The flexible display device of claim **3**, wherein the heat-dissipation path structure further comprises:

a first structural portion corresponding to the first housing;

a second structural portion corresponding to the hinge structure; and

a third structural portion corresponding to the second housing.

5. The flexible display device of claim **4**, wherein the heat conduction layer has a uniform thickness in the first structural portion, the second structural portion, and the third structural portion.

6. The flexible display device of claim **4**, wherein a first portion of the cover layer included in the second structural portion has a greater thickness than a second portion of the cover layer included in the first structural portion or the third structural portion.

7. The flexible display device of claim **1**, wherein the heat-dissipation path structure comprises:

a heat conduction layer that transfers the heat generated by the heat source;

a first structural portion corresponding to the first housing;

a second structural portion corresponding to the hinge structure;

a third structural portion corresponding to the second housing;

a first cover layer disposed on a first surface of the heat conduction layer; and

a second cover layer disposed on a second surface of the heat conduction layer,

wherein the second surface is opposite the first surface, and

wherein the first cover layer or the second cover layer has a uniform thickness in the first structural portion, the second structural portion, and the third structural portion.

8. The flexible display device of claim **7**, wherein the heat-dissipation path structure further comprises:

a third cover layer disposed on the first cover layer in the second structural portion; and

a fourth cover layer disposed on the second cover layer in the second structural portion, and

wherein the third cover layer or the fourth cover layer has a greater thickness than the first cover layer or the second cover layer.

9. The flexible display device of claim **8**, wherein the first cover layer and the second cover layer are formed of a polymer compound having a higher thermal conductivity than the third cover layer and the fourth cover layer.

10. The flexible display device of claim **8**, wherein the third cover layer and the fourth cover layer are formed of a polymer compound having a higher durability or flexibility than the first cover layer and the second cover layer.

11. The flexible display device of claim **7**, wherein the heat conduction layer comprises a slit structure formed in the second structural portion,

wherein the first cover layer and the second cover layer are attached to the heat conduction layer by an adhesive member, and

wherein the slit structure is filled with the adhesive member.

12. The flexible display device of claim **11**, wherein the slit structure is formed in a direction perpendicular to a folding axis of the hinge structure.

13. The flexible display device of claim **7**, wherein the heat conduction layer comprises a plurality of dot structures formed in the second structural portion,

wherein the first cover layer and the second cover layer are attached to the heat conduction layer by an adhesive member, and

wherein the plurality of dot structures are filled with the adhesive member.

14. The flexible display device of claim **1**, wherein the heat-dissipation path structure comprises:

a heat conduction layer that transfers the heat generated by the heat source;

a first structural portion corresponding to the first housing;

a second structural portion corresponding to the hinge structure;

a third structural portion corresponding to the second housing;

a first cover layer formed on a first surface of the heat conduction layer in the first structural portion;

a second cover layer formed on a second surface of the heat conduction layer in the first structural portion;

a third cover layer formed on a third surface of the heat conduction layer in the second structural portion; and

a fourth cover layer formed on a fourth surface of the heat conduction layer in the second structural portion,

wherein the second surface is opposite the first surface,

wherein the fourth surface is opposite the third surface,

wherein the first cover layer and the second cover layer have a first thickness, and

wherein the third cover layer and the fourth cover layer have a second thickness that is greater than the first thickness.

15. The flexible display device of claim **14**, wherein the heat-dissipation path structure further comprises:

a fifth cover layer formed on a fifth surface of the heat conduction layer in the third structural portion; and

a sixth cover layer formed on a sixth surface of the heat conduction layer in the third structural portion,

wherein the sixth surface is opposite the fifth surface, and

wherein the fifth cover layer and the sixth cover layer have the first thickness.

16. The flexible display device of claim **1**, wherein the heat-dissipation path structure comprises a flexible printed circuit board including a heat conduction layer and a dielectric layer,

wherein a first portion of the dielectric layer corresponding to the hinge structure has a different thickness than a second portion of the dielectric layer corresponding to the first housing or the second housing, and

wherein the heat conduction layer has a uniform thickness.

17. The flexible display device of claim **16**, wherein the second portion of the dielectric layer corresponding to the first housing includes a step corresponding to a size of the heat source.

18. The flexible display device of claim **1**, further comprising a second heat sink disposed in the first housing,

wherein at least a portion of the heat-dissipation path structure contacts at least one surface of the second heat sink.

19. The flexible display device of claim **1**, further comprising a heat pipe disposed in the first housing or the second housing,

wherein at least a portion of the heat-dissipation path structure contacts at least one surface of the heat pipe.

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